# Index

1. Public Procurement (Preference to Make in India) Order 2017- Notification of Telecom Goods, Services or Works

**Public Procurement (Preference to Make in India) Order 2017- Notification of Telecom Goods, Services or Works - regarding.**

F. No. 18-10/2017-IP

Reference:

i. Department of Industrial Policy & Promotion (DIPP) Order No. P-45021/2/2017- B.E.-II dated 15.06.2017
ii. Department of Industrial Policy & Promotion (DIPP) Order No. P-45021/2/2017-PP (BE-II) dated 28.05.2018 – Revision
i. Department for Promotion of Industry & Internal Trade (DPIIT) Order No. P-45021/2/2017 (B.E.-II) dated 29.05.2019 – Revision
I. Department for Promotion of Industry & Internal Trade (DPIIT) Order No. P-45021/2/2017 (B.E.-II) dated 04.06.2020 – Revision
II. Department for Promotion of Industry & Internal Trade (DPIIT) Order No. P-45021/2/2017 (B.E.-II) dated 16.09.2020 – Revision

The Government has issued Public Procurement (Preference to Make in India), Order 2017 (hereinafter called as "PPP-MII Order") vide the Department of Industrial Policy and Promotion (DIPP) Order No. P-45021/2/2017-B.E.-II dated 15.06.2017 which is further revised vide Order dated 28.05.2018, Order dated 29.05.2019, Order dated 04.06.2020 and Order dated 16.09.2020 to encourage 'Make in India' and to promote manufacturing and production of goods and services in India with a view to enhancing income and employment.

2. Department for Promotion of Industry & Internal Trade (DPIIT) has identified Department of Telecommunications as the nodal Department for implementing the provisions related to procurement of goods, services or works related to the telecommunication sector.

3. Accordingly, the Department of Telecommunications, in supersession of its earlier notification No. 18-10/2017-IP dated 29th August, 2018 issues this notification.

4. In terms of clauses 3(a) of the PPP-MII Order dated 16.09.2020, it is declared that following telecom products, services or works in Table A are having sufficient local capacity and local competition:

| **TABLE A Telecommunication Products** | |
|---|---|
| **Product Category** | **Proposed sub-categories / details** |
| 1. Encryption/ UTM platforms (TDM and IP) (Unified threat management) | 1.1 TDM |
| 1. Encryption/ UTM platforms (TDM and IP) (Unified threat management) | 1.2 IP |
| 2. IP/ MPLS Core routers/ Edge/Aggregation/ Enterprise Router | 2.1 Enterprise class IP Edge, Aggregation & Core Routers for Data Centre / Head Quarter / Regional HQ / Branch |
| 2. IP/ MPLS Core routers/ Edge/Aggregation/ Enterprise Router | 2.2 Cell Site Router (CSR); Carrier class Aggregation / Core / Backbone Routers (=< 4.8 T virtual routers |
| 2. IP/ MPLS Core routers/ Edge/Aggregation/ Enterprise Router | 2.3 Internet backbone Routers (with support for full internet routing table) or Backbo Router or Service Peering Router (> 4.8 Tbps); Carrier grade |

| | |
|---|---|
| 2. IP/ MPLS Core routers/ Edge/Aggregation/ Enterprise Router | 2.4 Carrier grade B-RAS |
| 2. IP/ MPLS Core routers/ Edge/Aggregation/ Enterprise Router | 2.5 SD-WAN Routers (SDN Category) Home / Enterprise - Core / Branch routers (< =1 Gbps |
| 3. Managed Leased line Network equipment - N*64 Kbps | 3.1 Managed Leased line Network equipment |
| 3. Managed Leased line Network equipment - N*64 Kbps | 3.2. IP Diversity Splitter and Combiner, Network Accelerator |
| 4. Ethernet Switches (L2 and L3) | 4.1 L2/L3 – 1-100 GbE interface Switches (Metro and Enterprise) (stackable / standalo switches), for Core / Distribution / Access Layers (including PoE/PoE+) |
| 4. Ethernet Switches (L2 and L3) | 4.2 Layer L2/L3 >100GbE -Core Switches, Enterprise / Carrier grade |
| 4. Ethernet Switches (L2 and L3) | 4.3 Industrial / Carrier Grade LAN 1, 10 GbE PoE/ PoE+/ Non-PoE Switches (Power over Eth |
| 5. IP based Soft Switches, IMS, Unified Communication Systems | 5.1 IP based Soft Switches, IMS, Unified Communication Systems: Enterprise class |
| 5. IP based Soft Switches, IMS, Unified Communication Systems | 5.2 IP based Soft Switches, IMS, Unified Communication Systems: Carrier class |
| 6.1 Wireline PABXs / IP PBX | 6.1 Wireline PABXs / IP PBX |
| 6.2 Media Gateways | 6.2.1 Media Gateways: Enterprise class |
| 6.2 Media Gateways | 6.2.2 Media Gateways: Carrier Class |
| 7.1 CPE (including Wi-Fi Access points and Routers, Media Converters), | 7.1.1 CPE (including Wi-Fi Access points and Routers with small capacities - home class] |
| 7.1 CPE (including Wi-Fi Access points and Routers, Media Converters), | 7.1.2 Media converter |
| 7.1 CPE (including Wi-Fi Access points and Routers, Media Converters), | 7.1.3 TDM over IP Converter |
| 7.2 2G/ 3G/ 4G LTE/5G Modems | 7.2.1 2G/ 3G/ 4G LTE Modems |
| 7.2 2G/ 3G/ 4G LTE/5G Modems | 7.2.2 5G Modems |
| 7.3 NFV/ SDN CPE | 7.3 All configurations of Cloud / Software Routers and Switches with SDN Controllers |
| 8. Set-Top Boxes | 8.1 SD Set-Top Boxes (Standard Definition) |

| | |
|---|---|
| 8. Set-Top Boxes | 8.2 HD Set-Top Boxes (High Definition) & Hybrid (RF and Ethernet tuners) Set Top Boxes a Top Boxes |
| 9.1 SDH/ NG-SDH | 9.1 SDH/ NG-SDH (STM 1/4/16/64) |
| 9.2 Carrier Ethernet/MPLS- TP/ Packet Optical Transport equipment/ PTN systems | 9.2 Carrier Ethernet/MPLS- TP/ Packet Optical Transport equipment/ PTN (with or interfaces) systems |
| 10. DWDM/ CWDM systems | 10.1 CWDM (Nx100G, Nx10G) |
| 10. DWDM/ CWDM systems | 10.2 DWDM (Nx10G, Nx100G+ Channels) with Mux/De MUX with Transponder / Muxpo (Reconfigurable Optical Add Drop Multiplexer), Passive DWDM MUX/DeMUX |
| 11.1 GPON equipment (including ONT and OLT) | 11.1 GPON/XGPON equipment (including ONU, ONT and OLT) |
| 11.2 XGS-PON, | 11.2 XGS-PON (10G DS – 10G US ) (including ONU, ONT and OLT) |
| 11.3 NG-PON2 | 11.3 NG-PON2 (40G DS – 10G US) (including ONU, ONT and OLT) |
| 12.1 SDH/ PDH Cross Connects | 12.1 SDH/ PDH Cross Connects<br>(STM: 1/4/16/64; E1/E3/DS3; Ethernet interfaces) |
| 12.2 Optical/OTN Cross-connects | 12.2.1 OTN Cross-connects |
| 13.1 Small size 2 G GSM based Base Station Systems, with its various derivatives including rural & disaster response, Macro & Micro BTS, Small Cells, NIB | 13.1.1 Macro 2G BTS |
| 13.1 Small size 2 G GSM based Base Station Systems, with its various derivatives including rural & disaster response, Macro & Micro BTS, Small Cells, NIB | 13.1.2 Micro 2G BTS |
| 13.1 Small size 2 G GSM based Base Station Systems, with its various derivatives including rural & disaster response, Macro & Micro BTS, Small Cells, NIB | 13.1.3 Pico 2G BTS |
| 13.1 Small size 2 G GSM based Base Station Systems, with its various derivatives including rural & disaster response, Macro & Micro BTS, Small Cells, NIB | 13.1.4 Femto 2G BTS |
| 13.1 Small size 2 G GSM based Base Station Systems, with its various derivatives including rural & disaster response, Macro & Micro BTS, Small Cells, NIB | 13.1.5 2G NIB Small cell |

| | |
|---|---|
| 13.1 Small size 2 G GSM based Base Station Systems, with its various derivatives including rural & disaster response, Macro & Micro BTS, Small Cells, NIB | 13.1.6 BSC/MSC Enterprise class |
| 13.2 Small size 3 G based Base Station Systems, with its various derivatives including rural & disaster response, Macro & Micro BTS, Small Cells, NIB, C-RAN BBU and RRH | 13.2.1 Macro 3G BTS |
| 13.2 Small size 3 G based Base Station Systems, with its various derivatives including rural & disaster response, Macro & Micro BTS, Small Cells, NIB, C-RAN BBU and RRH | 13.2.3 Pico 3G BTS |
| 13.2 Small size 3 G based Base Station Systems, with its various derivatives including rural & disaster response, Macro & Micro BTS, Small Cells, NIB, C-RAN BBU and RRH | 13.2.4 Femto 3G BTS |
| 14.1 2G GSM based Base Station Systems, with its various derivatives including rural & disaster response, Macro & Micro BTS, Small Cells, NIB, C-RAN BBU and RRH | 14.1.2 Micro 2G BTS |
| 15. Small Size LTE/ LTE-R Based Mobile Systems, with its various derivatives including rural & disaster communications, Macro & Micro eNodeB, Small Cells, EPC, NIB C-RAN BBU and RRH, LTE/ LTE-R/ LTE Advanced based broadband wireless access systems (eNodeB, gNB, EPC, etc.) in all standard LTE bands in the country | 15.1. Macro eNode B, Category 2, TEC ENB GR (TDD/FDD) |
| 15. Small Size LTE/ LTE-R Based Mobile Systems, with its various derivatives including rural & disaster communications, Macro & Micro eNodeB, Small Cells, EPC, NIB C-RAN BBU and RRH, LTE/ LTE-R/ LTE Advanced based broadband wireless access systems (eNodeB, gNB, EPC, etc.) in all standard LTE bands in the country | 15.2 Micro eNodeB, Category 2, TEC ENB GR (TDD/FDD) |
| 15.3 Pico eNodeB, Category 2, TEC ENB GR (TDD/FDD) | 15.3 Pico eNodeB, Category 2, TEC ENB GR (TDD/FDD) |
| 15.4 EPC (Enterprise class) | 15.4 EPC (Enterprise class) |
| 15.5 4G NIB Small cell | 15.5 4G NIB Small cell |
| 16.1 LTE/ LTE-R Based Mobile Systems, with its various derivatives including rural & disaster communications, Macro & Micro eNode B, Small Cells, EPC, NIB C-RAN BBU and RRH, LTE/ LTE-R/ LTE Advanced/ based broadband wireless access systems (eNodeB, EPC etc.) in all standard LTE bands in the country | 16.1.1. Wide Area eNode B, Category 1, TEC ENB GR (TDD/FDD) |

| | |
|---|---|
| 16.1 LTE/ LTE-R Based Mobile Systems, with its various derivatives including rural & disaster communications, Macro & Micro eNode B, Small Cells, EPC, NIB C-RAN BBU and RRH, LTE/ LTE-R/ LTE Advanced/ based broadband wireless access systems (eNodeB, EPC etc.) in all standard LTE bands in the country | 16.1.2. Medium range eNodeB, Category 1, TEC ENB GR (TDD/FDD) |
| 16.1 LTE/ LTE-R Based Mobile Systems, with its various derivatives including rural & disaster communications, Macro & Micro eNode B, Small Cells, EPC, NIB C-RAN BBU and RRH, LTE/ LTE-R/ LTE Advanced/ based broadband wireless access systems (eNodeB, EPC etc.) in all standard LTE bands in the country | 16.1.3 Local area eNodeB, Category 1, TEC ENB GR (TDD/FDD) |
| 16.1 LTE/ LTE-R Based Mobile Systems, with its various derivatives including rural & disaster communications, Macro & Micro eNode B, Small Cells, EPC, NIB C-RAN BBU and RRH, LTE/ LTE-R/ LTE Advanced/ based broadband wireless access systems (eNodeB, EPC etc.) in all standard LTE bands in the country | 16.1.4 EPC (Carrier class) (TEC EPC GR) |
| 16.2 5G Based broadband wireless infrastructure systems including gNodeB, 5G Core | 16.2.1 5G gNodeB (Base Station) including CRAN or DRAN or VRAN based architecture |
| 16.2 5G Based broadband wireless infrastructure systems including gNodeB, 5G Core | 16.2.2 5GC (Packet Core) - Carrier Class |
| 16.2 5G Based broadband wireless infrastructure systems including gNodeB, 5G Core | 16.2.3 5GC (Packet Core) - Enterprise Class |
| 17. Wi-Fi based broadband wireless access systems indoor & Outdoor (Including Access Point, Aggregation Block, Core Block) | 17.1 Indoor AP (802.11 ax MIMO, 2.4 & 5 GHz bands) |
| 17. Wi-Fi based broadband wireless access systems indoor & Outdoor (Including Access Point, Aggregation Block, Core Block) | 17.2 Indoor AP (802.11 ac MIMO, 2.4 & 5 GHz bands) |
| 17.3 Outdoor AP (802.11ac - MIMO 2.4 and 5 GHz bands - IP67 Rated | 17.3 Outdoor AP (802.11ac - MIMO 2.4 and 5 GHz bands - IP67 Rated |
| 17.4 Outdoor AP (802.11n/b/g - MIMO 2.4 and 5 GHz bands - IP67 rated | 17.4 Outdoor AP (802.11n/b/g - MIMO 2.4 and 5 GHz bands - IP67 rated |
| 17 A. Wi-Fi Access Controller (with interoperability and multi-vendor AP support) | 17.A.1 Type 1: <= 2000 AP support |

| | |
|---|---|
| 17 A. Wi-Fi Access Controller (with interoperability and multi-vendor AP support) | 17.A.2 Type 2: >2000 AP support |
| 17 B. AAA block (Authentication, Authorization & Accounting) | 17.B.1 Enterprise grade AAA Block (Radius) |
| 17 B. AAA block (Authentication, Authorization & Accounting) | 17.B.2 Carrier grade AAA block (Radius/ Diameter) |
| 18. Radio systems (IP/ Hybrid), Mobile Front haul BBU and RRH (CPRI, eCPRI, FlexE, RoE, NGFI) | 18.1 Radio systems (IP/ Hybrid), Mobile Front haul BBU and RRH (CPRI, eCPRI, FlexE, RoE, I band)) |
| 18. Radio systems (IP/ Hybrid), Mobile Front haul BBU and RRH (CPRI, eCPRI, FlexE, RoE, NGFI) | 18.1 Radio systems (IP/ Hybrid), Mobile Front haul BBU and RRH (CPRI, eCPRI, FlexE, RoE, I band)) |
| 18. Radio systems (IP/ Hybrid), Mobile Front haul BBU and RRH (CPRI, eCPRI, FlexE, RoE, NGFI) | 18.2 Radio systems (IP/ Hybrid), Mobile - Front / Mid / Back haul BBU and RRH (CPRI, eCP NGFI) (52-71 GHz) |
| 18. Radio systems (IP/ Hybrid), Mobile Front haul BBU and RRH (CPRI, eCPRI, FlexE, RoE, NGFI) | 18.4 Radio systems (IP/ Hybrid), Mobile - Front / Mid / Back haul BBU and RRH (CPRI, eCP NGFI) (71-90 GHz)) |
| 19. Software Defined Radio, Cognitive Radio systems (all bands) | Ruggedised handheld, Ruggedised or non-ruggedised vehicle mounts, P2P OR P2MP or topology, Licensed /Unlicensed band operation |
| 20. Repeaters (RF/RF-over-Optical), IBS and Distributed Antenna systems (indoor / outdoor) including Active & Passive Accessories | 20. Repeaters (RF/RF-over-Optical), IBS and Distributed Antenna systems (indoor / outd Active & Passive Accessories |
| 21. Satellite based systems | |
| 21.1 VSAT Systems | |
| | |
| | |
| | |
| 21.1 VSAT Systems | 21.1.2 VSAT Hub Equipment (including SSPA, LNA, Mod / De Mod), U/D Converter, Accelerator, NMS S/W, RF-Fibre converter, Antenna, and accessories etc.)<br>C, L, S, Ku, Ka Bands |
| 21.1 VSAT Systems | 21.1.3 VSAT Terminals Shipborne (including Modem/BUC & LNB, Accelerator) along with antenna and accessories<br>C, L, S, Ku, Ka Bands |
| 21.1 VSAT Systems | 21.1.4 VSAT Terminals Airborne (including Modem/BUC & LNB, Accelerator) along with antenna and accessories<br>C, L, S, Ku, Ka Bands |
| 21.2 VSAT terminal Subsystem - IDUs | 21.2.1 SCPC |

| | |
|---|---|
| | 21.2.2 MF TDMA (Mesh) (DVB RCS, DVB RCS II) |
| | 21.2.3 MF TDMA (Star) (DVB RCS, DVB RCS II) |
| 21.3 VSAT Terminal Subsystem - ODUs | 21.3.1 BUC |
| | 21.3.2 LNB |
| | 21.3.3 Antenna |
| 21.4 VSAT Hub Subsystems | SSPA<br>RF U / D Conv<br>Mod / De Mod<br>LNA<br>Accelerator<br>NMS S/W<br>RF to Fibre Converter<br>Antenna and accessories etc. |
| 21.5. Disaster Communication Systems etc., including backpack satellite products | C, Ka, Ku, L, S Bands |
| 21.5. Disaster Communication Systems etc., including backpack satellite products | TEC GR (TEC / TS TP / TX / PVT -01/01/JAN - 11) for Portable Terminals Voice and Data (2 Mbps UL) |
| 21.6. Satellite based IoT Systems including location, resources tracking | Bands (L, S and Ku, *Ka* bands) |
| 21.7.1 Two-way MSS Data Terminals (Satellite Receivers with location data) | Satellite IoT devices for various applications position tracking, messaging etc. |
| 21.7.2 One Way Receivers (Satellite Transmitters & Receivers) | Half-duplex and full-duplex modems, VSAT Modems, Mobile Satellite Service (MSS) terminals, Satellite Phones ( L band & S-band ), Satellite IoT devices |
| 21.7.3 Hub side Baseband Equipment & Software | Including Mod / De Mod) , Accelerator, NMS S/W etc., based on open standards |
| 21.7.3 Hub side Baseband Equipment & Software | Satellite Broadcast receivers, IP receive only terminals, Portable messaging terminals, Location reporting terminals |
| 21.8 Other satellite equipment | Burst & Continuous Modems/Demodems, TDM & Burst Modulators, Hub-NMS Software, IP Encryptors |
| 21.5 Satellite Phones | Both Voice and Data (upto 9.6 Kbps) |
| | Both Voice and Data (> 9.6 Kbps) |

| | |
|---|---|
| 22. Copper access systems (DSL/ DSLAM), high-speed xDSL (G.fast) | 22. Copper access systems (DSL/ DSLAM), high-speed xDSL (G.fast) |
| 23. Telecom Network Management systems (NMS) with its various derivatives including Operation Support System (OSS), Billing Support System (BSS), Trouble Ticketing System (TTS) | 23.1 Carrier class |
| 23. Telecom Network Management systems (NMS) with its various derivatives | 23.2Enterprise Class |
| 24. Telecom OSS with its various derivatives | 24.2 Service Fulfilment sysytem |
| 24. Telecom OSS with its various derivatives | 24.3 Inventory Management |
| 24. Telecom OSS with its various derivatives | 24.4 Geographical Information System (GIS) |
| 25. Security and Surveillance Communication Systems (video and sensors based) including Perimeter Security Systems | 25. Security and Surveillance Communication Systems (video and sensors based) including Perimeter Security Systems |
| 25. Security and Surveillance Communication Systems (video and sensors based) including Perimeter Security Systems | 25.1 Dual Sensor PTZ Camera |
| 25. Security and Surveillance Communication Systems (video and sensors based) including Perimeter Security Systems | 25.2 M2M Remote Management Portal |
| 25. Security and Surveillance Communication Systems (video and sensors based) including Perimeter Security Systems | 25.2 Aerial Security System using autonomous RPA |
| 26.1 Optical Fiber | Optical Fiber; Single Mode / Multimode |
| 26. 2. Optical Fiber Cable | 26.2.1 Overhead |
| 26. 2. Optical Fiber Cable | 26.2.2 Underground |
| 26. 2. Optical Fiber Cable | 26.2.3 Submarine |
| 26. 2. Optical Fiber Cable | 26.2.4 Accessories |
| 27. Telecom Power System (Including Solar Power) | 27.1 UPS, Power Plant, Invertor (Including Solar Power) 0.5-1500 KVA |
| 27. Telecom Power System (Including Solar Power) | 27.2 Power Plant: (Modular) |
| 28. Telecom Batteries (Lead Acid & Li-ion) | 28.1 Telecom Batteries (Lead Acid) 250-5000 AH (Including VRLA) |

| | |
|---|---|
| 28. Telecom Batteries (Lead Acid & Li-ion) | 28.2 Li-Ion Batteries |
| 29. IP audio phones / IP video Phones / Analog adaptor | 29. IP audio phones / IP video Phones / Analog adaptor |
| 30. SDN Software Controllers, NVF and CNF software | 30. SDN Software Controllers, NVF and CNF software |
| 31. Services from Telecom Cloud infrastructure/ Telecom Data centers | 31.1 Spine Switches (10G/25G/50G/100G interfaces) |
| 31. Services from Telecom Cloud infrastructure/ Telecom Data centers | 31.2 Top of Rack Switches (10G/25G/50G/100G interfaces) |
| 32. 2-way Analog/ Digital radio including Walkie-Talkie & Mobile Radio | 32. 2-way Analog/ Digital radio including Walkie-Talkie & Mobile Radio |
| 33. Batteries of 2-way Analog/ Digital radio including Walkie-Talkie | 33. Batteries of 2-way Analog/ Digital radio including Walkie-Talkie |
| 34. Optical Fiber Monitoring System | 34.1 OTDR - RTU Single / Multi Fiber; |
| 34. Optical Fiber Monitoring System | 34.2 Remote Fiber Monitoring & Testing System (Software) |
| 35. M2M/ IOT Subsystems including NB IoT in different verticals | 35.1 M2M/ IOT Subsystems including NB IoT in different verticals |
| 35. M2M/ IOT Subsystems including NB IoT in different verticals | 35.2 Customer Feedback Device, Portal and Analytics |
| 35. M2M/ IOT Subsystems including NB IoT in different verticals | 35.3 M2M Security Client & Platform |
| 35. M2M/ IOT Subsystems including NB IoT in different verticals | 35.4 M2M Remote Management Portal |
| 35. M2M/ IOT Subsystems including NB IoT in different verticals | 35.4 Multi-Protocol IoT Gateway |
| 35. M2M/ IOT Subsystems including NB IoT in different verticals | 35.5 Multi-Protocol IoT Headend |
| 35. M2M/ IOT Subsystems including NB IoT in different verticals | 35.6 Vehicle Tracking and Alarms Management |
| 36. Gateways: GSM, V0IP, Signalling | Enterprise GSM, VoIP |
| 37. Remote Piloted Aircrafts (RPA) as defined by Bureau of Civil Aviation [Drones / UAVs (Unmanned Aerial Vehicles)] | 37.1.1 nano: less than or equal to 250g; |
| 37. Remote Piloted Aircrafts (RPA) as defined by Bureau of Civil Aviation [Drones / UAVs (Unmanned Aerial Vehicles)] | 37.1.2 micro: greater than 250g and less than or equal to 2g; |

| | |
|---|---|
| 37. Remote Piloted Aircrafts (RPA) as defined by Bureau of Civil Aviation [Drones / UAVs (Unmanned Aerial Vehicles)] | 37.1.3 small: greater than 2kg and less than or equal to 25kg; |
| 37. Remote Piloted Aircrafts (RPA) as defined by Bureau of Civil Aviation [Drones / UAVs (Unmanned Aerial Vehicles)] | 37.1.3 small: greater than 2kg and less than or equal to 25kg; |
| 37. Remote Piloted Aircrafts (RPA) as defined by Bureau of Civil Aviation [Drones / UAVs (Unmanned Aerial Vehicles)] | 37.1.3 small: greater than 2kg and less than or equal to 25kg; |
| 37. Remote Piloted Aircrafts (RPA) as defined by Bureau of Civil Aviation [Drones / UAVs (Unmanned Aerial Vehicles)] | 37.1.4 medium: greater than 25kg and less than or equal to 150kg; and |
| 37. Remote Piloted Aircrafts (RPA) as defined by Bureau of Civil Aviation [Drones / UAVs (Unmanned Aerial Vehicles)] | 37.1.5 large: greater than 150kg. |
| 38. Camera including long range camera, IP camera & Recorders, Night vision cameras | Including Web camera /IP camera /Thermal camera /Dome camera /Bullet camera /Indoor & Outdoor camera /Smart, voice integrated cameras |
| 39. Telecom Billing Support System (BSS) with all its derivatives | 39. Telecom Billing Support System (BSS) with all its derivatives |
| 40. Video Conferencing Applications | 40. Video Conferencing Applications |
| 41 Terrestrial Communication | 41.1 Tropo-scatter antennas |
| 41 Terrestrial Communication | 41.1 Line of Sight (LoS ) antennas (Pt-Pt & Pt-Multi Pt) |
| 42 Satellite Communication- Ground/ Earth Station Antennas | 42 Satellite Communication- Ground/ Earth Station Antennas |
| 43. Lawful Logging Platform - IPFIX, Syslog, CG-NAT, NAT logs, etc. | 43. Lawful Logging Platform - IPFIX, Syslog, CG-NAT, NAT logs, etc. |
| 44. CAP based Early Warning Platform for Disaster situations | 44. CAP based Early Warning Platform for Disaster situations |
| 45. Cloud Computing | 45. Deployment of Private Cloud |
| 46. GNSS based Time Servers (including navIC) NTP. IEEE 1588/PTP for Time Synchronisation and Standalone GNSS receiver for location information | 46. GNSS based Time Servers (including navIC) NTP. IEEE 1588/PTP for Time Synchronisation and Standalone GNSS receiver for location information |
| 47. Conditional Access System for Broadcast networks | 47. Conditional Access System for Broadcast networks |
| 48. Embedded Transaction Device | 48. Point of Sale Device |

| | |
|---|---|
| 49. Digital Rights Management (DRM) | 49. Digital Rights Management (DRM) |
| 50. USB based security device | 50. PKI Token |
| 51. Light-Fidelity (Li-Fi) Technology based Access points and receiver for Short-range Indoor Communication | 51. Indigenous prototype development for Indoor bi-directional communication based on Li-Fi technology with maximum data rate support |
| 52. Secure Chat and Call Platform | 52. Secure Chat and Call Platform |
| 53. Quantum Key Distribution (QKD) | 53. Quantum Key Distribution (QKD) |
| 54. Time Reference Server | 54. G3I Based NTP/PTP Time Reference Server |
| 55. DMR (Digital Mobile Radio in UHF & VHF band) | 55. DMR (Digital Mobile Radio in UHF & VHF band) |
| 56. AAA & TACACS appliances for smart cities | 56. AAA & TACACS appliances for smart cities |
| 57. U1 optical amplifier | 57. C band+ L band optical amplifier |
| 58. 5G Channel Recorder and Spectrum Analyzer | 58. 5G Channel Recorder and Spectrum Analyzer |
| 59. pre-fab shelter for BTS/Exchanges | 59. pre-fab shelter for BTS/Exchanges |
| 60. 5G Core Testing Tool | 60. 5G Core Testing Tool |
| 61. 5G NAS STACK | 61. 5G NAS STACK deployment on IOT Devices make them 5G Capable |
| 62 5G Edge networking platform | 62. Cloud-native 5G Edge networking platform for Enterprises |
| 63. 5G Satcom | 63. 5G Satcom |
| 64. Integrated back haul 5g relay systems | 64. Integrated back haul 5g relay systems |
| 65. mm Wave Systems | 65. mm Wave Systems |
| 66. Mobile Phone for Broadcast Signals | 66. Mobile Phone for Broadcast Signals |
| 67. NB-IoT Geo Satellite Systems | 67. NB-IoT Geo Satellite Systems |

| | |
|---|---|
| 68. NB-IoT Skylo Hub | 68. NB-IoT Skylo Hub |
| 69 Home Automation based on WiFi or sub-GHz solutions including sensors, remotes | Solutions for home, enterprise, office automation, other applications of IoT modules with secure cloud access |
| 70 IoT Modules | WiFi, LoRa, 802.15.4g, NB IoT based modules that are used with various applications in sectors of power, automotive, home, enterprise |
| 71. Towers / Masts / Poles | 71.1. Portable Footing-based Towers / Masts for 4G/5G<br>71.2. Skid-based Towers / Masts for 4G/5G<br>71.3. Cell on Wheels (COWs) for 4G/5G<br>71.4. Rooftop Towers / Masts for 4G/5G<br>71.5. Poles for 5G<br>71.6. OFC Junction Chambers & Manholes |
| 72. 5G Based Mobile Systems | 72.1 Macro RU |
| 72. 5G Based Mobile Systems | 72.2 Indoor RU |
| 73. 5G CPE | 73. 5G CPE |
| 74. Over-the-Air Technology | 74.1 Over-the-Air Technology (SIM & Device Management) |
| 74. Over-the-Air Technology | 74.2 On Demand SIM Activation (White Labelled SIM Card) |
| 74. Over-the-Air Technology | 74.3 SIM Based Roaming Steering, Mobile ID, Quality of Service, Emergency/Presidential Alerts |
| 75. Drone Communication | 74. Drone Communication |
| 76. SCADA System for Telecom Networks | 75. Infrastructure Monitoring System (Software and Hardware (RTU) deployed for monitoring & controlling Telecom Infra like Tower Sites, Point of Presence (POPs), Submarine Cable Landing Stations (CLS), etc from a Central Location.) |
| 77. Cyber Threat Detection, Visibility and Forensics | 76.1 Flow based Threat Detection using AI/ML<br>76.2 Firewalls |
| 78. Unified Communications and IP Telephony | 77. IP PBX |
| 79. Customer Premises Media Gateways | 78. Customer Premises Media Gateways |
| 80. VoIP and SIP Phones (User Terminals Phones) | 79. VoIP and SIP Phones |
| 81. Power Line Communication Carrier Equipment | 80. PLCC Switches |

| | |
|---|---|
| 82. Secured OTP System to avoid frauds | 82.1 Secured OTP System to avoid frauds (Software in SIM and Server) |
| 82. Secured OTP System to avoid frauds | 82.2 Non-OTP Based Secure authentication |
| 83. SIM Applets for Subscription Management & Control | Card Operating Systems and Apps |
| 84. Remote management platforms for SIM, Subscription and Device enablement | Remote Management |
| 85. Position Velocity and Time Data and Alarms Management | IoT Data Management |
| 86. Remote Device Management & Data Acquisition | Common Service Layer Platforms |
| 87. IoT Based Customer Feedback Devices | IoT Device |
| 88. IoT based SCADA Devices | IoT Device |
| 89. Secure Element based Identity and Encryption Systems | IoT Security |
| 90 IP TV | 90 IP TV |
| 91. Mesh network of Hardware, Cloud, analytics, and Software | 91. Mesh network of Hardware, Cloud, analytics, and Software |
| 92. Distributed Unit (DU) | 92. ORAN 7.2x/ support 4G/ 5G/ NB-IOT |
| 93. Portable RAN Framework | 93. Portable RAN framework for DU to make it hardware agnostic |

TEC Specification where-ever available and certification shall be the preferred choice.

The list will be reviewed time to time to keep up with improved production capacities in the country and availability of Indian global innovations and solutions.

5. The definition of Local Content shall be as per clause 2 of the PPP-MII Order dated 16.09.2020. In accordance with clause 5 of the PPP-MII Order dated 16.09.2020, it is hereby clarified that

Domestic Local Content will be calculated without considering Profits, transportation, insurance, installation & commissioning, training & any after sales and services support like AMC/CMC etc. The Domestic Local Content (LC) can be claimed as follows:

A) If all Printed Circuit Board Assembly (PCBA) and testing from components is done using Surface Mounting Technology (SMT) process in India, then the same will qualify for a maximum of 10% of the overall local content claimed. If only few PCBA are done in India using SMT, then the same will be proportionately reduced.

B) Since Design (system, hardware, software) is a critical input for manufacturing of telecom equipment, the same can be claimed against Domestic Local Content, provided the Intellectual Property Right (IPR) of the design belongs to the Indian Company and the global profits from sales of such equipment, accrue to the Indian company that owns the IPR/design/copyright, as per the following guidelines:

(i) If all the system design as well as hardware design is done in India, then 20% of Domestic Local content can be claimed.

(ii) If the software design, testcase design is done in India, then an additional 20% of the Domestic Local content can be claimed

To claim the above local content, the Indian company should be DSIR registered R&D house, and the IPR/source code should reside in India and be subject to inspection by any Government designated agency.

All input material such as Components, bare PCB, Cables, Chassis, Mechanicals etc. that are manufactured in India, can be claimed as Domestic Local content.

6. In terms of clause 9(d) of PPP-MII Order dated 16.09.2020, the following Committee is constituted for complaints and independent verification of self-declarations and auditor's/accountant's certificates on random basis:

| | | |
|---|---|---|
| a | DDG(TC), TEC, New Delhi | - |
| b | Director (Technical), C-DOT | - Member |
| c | Any other member(s) as co-opted by the | - Member |
| d | DG, TEPC | - Member |
| e | Director (Finance), DoT | - Member |
| f | Director, TEC | - |

7. In case a complaint is received by the procuring entity or the concerned Ministry/Department against the claim of a bidder regarding Local Content (LC) in a locally supplied telecom goods, services or works, the same shall be referred to the Committee as in para 6 above. The Committee should dispose of the complaint within 4 weeks, as far as possible, from the date of receipt of complaint along with all necessary documentation in support of Local Content claimed by the bidder.

8. In terms of clause 9 (e) of PPP-MII Order dated 16.09.2020, it is hereby notified that there will be a minimum complaint fee of Rs. 2 Lakh or 1% of the value of the locally supplied telecom goods, services or works being procured (subject to a maximum of Rs. 5 Lakh), whichever is higher, to be paid by Demand Draft or online, and to be deposited with Telecommunications Engineering Centre (TEC), as the case may be, or with any other third party testing laboratories or technical auditors accredited by TEC along with the complaint by the complainant. Complaint fee may be 50% for MSME companies. In case, the complaint is found to be incorrect, the complaint fee shall be forfeited. In case, the complaint is upheld in part or full, deposited fee of the complainant will be refunded without any interest.

9. In terms of clause 9(a) of PPP-MII Order, the local supplier at the time of tender, bidding or solicitation

shall provide self-certification in Form-1 specifying that the item offered meets the minimum local content and shall give details of the location(s) at which the local value addition is made.

10. Each identified products, services or works as in Table-A shall comply with the latest TEC GR/IR, if such GR/IR have been issued. The procuring entity may ensure that prior experience clause is not too restrictive to exclude all local suppliers of telecom product, services or works. All Procurement Officers may be required to certify compliance of this order before uploading tenders on Central Public Procurement Portal (CPPP) or any other portal. Disciplinary action will be taken against erring officers who insert restrictive tender conditions against local suppliers with a malafide intent or otherwise flout the provisions of PPP-MII Order.

11. For compliance of GR/ IR, certification from Indian bodies i.e. TEC/ TSEC or any accredited lab by TEC, is a mandatory requirement to be submitted by the bidder. For any telecom product, service and work as in Table-A, the procuring entity should not specify to bidder to mandatory qualify any foreign eligibility specifications or certification(s) issued by any foreign testing/security lab(s).

12. The notification would also be applicable to all Central Schemes (CS)/ Central Sector Schemes (CSS) for which procurement is made by States and local bodies, if that project or scheme is fully or partially funded by Government of India including Universal Service Obligation Fund (USOF) projects.

13. The Notification comes into effect immediately and will remain in force till any further revision is made. It is clarified that, except specific amendments to Nodal Ministry, all other revisions/amendments in PPP-MII Order, 2017 shall be followed strictly.

## Form – 1

**(Same as 29th Aug 2018 PMI policy)**

**Format for Self-Certification regarding Local Content (LC) for Telecom Product, Services or Works**

**Date:**

_____ S/o, D **/o, W/o**_____**,** Resident of _____ do hereby solemnly affirm and declare as under:

That I agree to abide by the terms and conditions of Department of Telecommunications, Government of India issued vide Notification No: ……. dated …….

That the information furnished hereinafter is correct to best of my knowledge and belief and I undertake to produce relevant records before the procuring entity or any other authority so nominated by the Department of Telecommunications, Government of India for the purpose of assessing the LC.

That the LC for all inputs which constitute the said Telecom Product/Services/Works has been verified by me and I am responsible for the correctness of the claims made therein.

That in the event of the LC of the Telecom Product/Services/Works mentioned herein is found to be incorrect and not meeting the prescribed LC norms, based on the assessment of an authority so nominated by the Department of Telecommunications, Government of India and I will be liable as under clause 9 (f) of **Public Procurement (Preference to Make in India) Order 2017**.

I agree to maintain all information regarding my claim for LC in the Company's record for a period of 2 years and shall make this available for verification to any statutory authorities.

i. Name and details of the Local supplier (Registered Office, Manufacturing unit location, nature of legal entity)
ii. Date on which this certificate is issued
iii. Telecom Product/Services/Works for which the certificate is produced
iv. Procuring agency to whom the certificate is furnished
v. Percentage of LC claimed
vi. Name and contact details of the unit of the manufacturer
vii. Sale Price of the product
viii. Ex-Factory Price of the products
ix. Freight, insurance, and handling
x. Total Bill of Material
xi. List and total cost value of inputs used for manufacture of the Telecom Product/Services/Works
xii. List and total cost of inputs which are locally sourced. Please attach LC certificates from local suppliers if the input is not in-house.
xiii. List and cost of inputs which are imported, directly or indirectly

**1.** **For and on behalf of___(Name of firm/entity)**

Authorized signatory (To be duly authorized by the Board of Directors)

# 1.1 Additional Inputs in support of products in Table 1 of S.No. 1 above : Multiple suppliers against each product

| Proposed sub-categories / details | Company details including website, contact details |
|---|---|
| 1.1 TDM | 1. BEL 2. Infinity Labs Ltd. 3. ECIL 4. CDOT and its licensees 5. ITI 6. Quickheal (Seqrite), 7 Tejas Networks, 8. Nivetti Systems 9. Inventum Technologies Pvt Ltd |
| 1.2 IP | 1. BEL 2. Infinity Labs Ltd. 3. CDOT and its licensees 4. ITI 5. Tejas Networks, 6. Inventum Technologies Pvt Ltd |
| 2.1 Enterprise class IP Edge, Aggregation & Core Routers for Data Centre / Head Quarter / Regional HQ / Branch | 1. Nivetti 2. CDoT ToT: BEL BLR, ECIL, ITI BLR, BEL-KOT 3. Inventum Technologies 4. HFCL 5. Tejas Networks Ltd 6. Lavelle Networks 7. MRO Tek 8. United Telecom Ltd. 9. Infinity Labs Ltd 10. Niral |
| 2.2 Cell Site Router (CSR); Carrier class Aggregation / Core / Backbone Routers (=< 4.8 Tbps) including virtual routers | 1. Tejas Networks 2. Nivetti Systems 3. CDoT ToT: BEL BLR , BEL KOT, ECIL, ITI BLR 4. HFCL 5. United Telecom Ltd 6. Niral 7. Inventum |
| 2.3 Internet backbone Routers ( with support for full internet routing table) or Backbone Super Core Router or Service Peering Router (> 4.8 Tbps); Carrier grade | 1. Inventum 2.C-DOT and its Licensees |
| 2.4 Carrier grade B-RAS | 1. C-DOT and its Licensees 2. Inventum Technologies 3. United Technologies |
| 2.5 SD-WAN Routers (SDN Category) Home / Enterprise - Core / Branch routers (< =1 Gbps) | 1. Lavelle Networks 2. Nubewell 3. Arakya 4. Tejas Networks 5. Nivetti Systems 6. Indio Networks 7. Infinity Labs 8. Inventum Technologies 9. HFCL 10. United Telecom |
| 3.1 Managed Leased line Network equipment | 1. Priamatel 2. Tejas Networks 3. ITI 4. CDoT and its Licensees |
| 3.2. IP Diversity Splitter and Combiner, Network Accelerator | 1. BEL 2. ITI |
| 4.1 L2/L3 – 1-100 GbE interface Switches (Metro and Enterprise) (stackable / standalones / modular switches), for Core / Distribution / Access Layers (including PoE/PoE+) | 1. Tejas Networks 2. Nivetti Systems 3. C-DoT ToT: BEL 4. Primatel 5. MRO Tek 6. HFCL 7. United Telecom |
| 4.2 Layer L2/L3 >100GbE –Core Switches, Enterprise / Carrier grade | 1. Tejas Networks 2. Nivetti Systems 3. C-DoT ToT: BEL 4. Primatel 5. HFC 6. United Telecom |
| 4.3 Industrial / Carrier Grade LAN 1, 10 GbE PoE/ PoE+/ Non-PoE Switches (Power over Ethernet) | 1. Tejas Networks 2. Nivetti Systems 3. C-DoT ToT: BEL 4. Sands India 5. MRO Tek 6. HFCL 7. Indio Networks 8. United Telecom 9. VVDN Technologies |

| | |
|---|---|
| 5.1 IP based Soft Switches, IMS, Unified Communication Systems: Enterprise class | 1. Coral Telecom Ltd. 2. Accord Communications Ltd. 3. NXG ( Nexge Technologies(P) Ltd.) 4. Elcom Innovations Ltd. 5. Matrix Comsec Pvt. Ltd. 6. AstTech Banglore 7. C-DoT ToT: BEL |
| 5.2 IP based Soft Switches, IMS, Unified Communication Systems: Carrier class | 1. Sterlite Technologies Limited 2. NXG ( Nexge Technologies(P) Ltd.) 3. CDOT 4. BEL 5. |
| 6.1 Wireline PABXs / IP PBX | 1. Coral Telecom 2. Astech 3. Accord Communications 4. Matrix Comsec Pvt Ltd 5. Dialtronics 6. DSP Works |
| 6.2.1 Media Gateways: Enterprise class | 1. Coral Telecom Ltd 2. Dialtronics Systems pvt. Ltd. 3. Matrix Comsec pvt. Ltd 4. Sangoma 5. AstTech Banglore 6. Vihaas Design Technologies 7. Elcom Innovation Ltd. 8. CDoT 9. BEL |
| 6.2.2 Media Gateways: Carrier Class | CDOT, BEL |
| 7.1.1 CPE (including Wi-Fi Access points and Routers), [Routers- These are small capacities - home class] | 1. C-DoT ToT: KAYNES 2. C-DoT ToT: CYIENT 3. CDOT ECIL 4. CDOT ITI 5. HFCL 6. SandsIndia 7. Digisol 8. C-DoT ToT: BEL 9.SCTPL 10. C-DoT ToT: UTL Technologies 11. HFCL 12. COMINT 13. Tarangg (MSME) 12. Elcom 13. Agressive 14. CDOT ToT RCV 14. C-DoT ToT: System Control 15. C-DoT ToT: RCV 16. Primatel 17. Kenstel Networks 17. VVDN Technologies 18. Kirat Communication 19. Infinity Labs 20. WiSig |
| 7.1.2 Media converter | 1. MATRIX COMSEC PVT. 2. Primatel 3. UTL 4. MRO-Tek 5. CDoT 6. BEL 7. HFCL |
| 7.1.3 TDM over IP Converter | 1. MATRIX COMSEC PVT. LTD. 2. Primatel 3. BEL 4. Dialtronics |
| 7.2.1 2G/ 3G/ 4G LTE Modems | 1. MATRIX COMSEC PVT. LTD. 2. VVDN Technologies 3. CDoT 4. BEL 5. Indio Networks 6. UTL 7. Makers Village Cavli Wireless 8. Vista |
| 7.2.2 5G Modems | 1. WiSig 2. HFCL 3. VVDN |
| | 1. Primatel 2. Tejas Networks Ltd 3. MRO Tek 4. CDOT 5. Sands India |
| All configurations of Cloud / Software Routers and Switches with SDN Controllers | 1. Nubewell 2. Lavelle Networks 3. Tejas Networks Ltd. 4. MRO Tech 5. Vilankini 6. Nivetti Systems 7. CDOT 8. Infinity Labs 9. Inventum Labs 10.UTL 11. VVDN Technologies |
| 8.1 SD Set-Top Boxes (Standard Definition) | 1. C-DoT ToT: Surabhi 2. MYBOX 3. Trend Electronics 4. Logic Eastern 5. Dixon 6. Catvision Ltd 7. STB Technologies Pvt. Ltd 8. Velankani Group 9. Exza InfoSystems 10. UTL 11. MCBS |
| 8.2 HD Set-Top Boxes (High Definition) & Hybrid (RF and Ethernet tuners) Set Top Boxes and Android Set Top Boxes | 1. C-DOT 2.My Box Tech 3. UTL 4. Catvision 5. Exza Infosystem 6. Valankani Group 9. MCBS |

| | |
|---|---|
| 9.1 SDH/ NG-SDH (STM 1/4/16/64) | 1. C-DoT 2. FIBCOM 3. Primatel 4. TEJAS Networks Ltd 5. ITI |
| 9.2 Carrier Ethernet/MPLS- TP/ Packet Optical Transport equipment/ PTN (with or without OTN interfaces) systems | 1. C-DoT 2. FIBCOM 3. Primatel 4. TEJAS Networks Ltd 5. UTL |
| 10.1 CWDM (Nx100G,Nx10G) | 1. Tejas Networks 2. UTL 3. Fibcom |
| | |
| 10.2 DWDM (Nx10G, Nx100G+ Channels ) with Mux/De MUX with Transponder / Muxponder; ROADM (Reconfigurable Optical Add Drop Multiplexer), Passive DWDM MUX/DeMUX | 1. Tejas Networks 2. UTL 3. C-DoT 4. Fibcom |
| 11.1 GPON/XGPON equipment (including ONU, ONT and OLT) | 1. C-DoT ToT: BEL 2. C-DoT ToT: KAYNES 3. C-DoT ToT: CYIENT 4. C-DoT ToT: ITI Ltd 5. TEJAS Networks Ltd 6. C-DoT ToT: UTL Technologies Ltd. 7. Alphion 8. Kenstel Networks 8. STCPL 9. HFCL 10. VMC 11. VVDN Technologies |
| 11.2 XGS-PON (10G DS – 10G US ) (including ONU, ONT and OLT) | 1. C-DoT ToT: BEL 2. C-DoT ToT: KAYNES 3. C-DoT ToT: CYIENT 4. C-DoT ToT: ITI Ltd 5. C-DoT ToT: UTL Technologies Ltd. 6. TEJAS Networks Ltd 7. Alphion |
| 11.3 NG-PON2 (40G DS – 10G US) (including ONU, ONT and OLT) | 1.Tejas Networks Ltd 2. CDoT (HFCL Cyient ITI) 3. UTL |
| 12.1 SDH/ PDH Cross Connects (STM : 1/4/16/64; E1/E3/DS3; Ethernet interfaces) | 1. C-DoT 2. FIBCOM 3. Primatel 4. TEJAS Networks Ltd 5. UTL |
| 12.2.1 OTN Cross-connects | 1. C-DoT 2. FIBCOM 3. Primatel 4. TEJAS Networks Ltd 5. UTL 6. Sterlite Technologies |
| 13.1.1 Macro 2G BTS | 1. VNL Ltd 2. HFCL 3. Fibcom 4. CDoT |
| 13.1.2 Micro 2G BTS | 1. VNL 2. C-DOT 3. ITI 4. HFCL |
| 13.1.3 Pico 2G BTS | 1. 2. HFCL 3. Fibcom 3. VNL |
| 13.1.4 Femto 2G BTS | 1. Fibcom 2. HFCL Limited |
| 13.1.5 2G NIB Small cell | 1. VNL 2. FIBCOM 3. HFCL |
| 13.1.6 BSC/MSC Enterprise class | 1. HFCL Limited 2. Fibcom |

| | |
|---|---|
| 13.2.1 Macro 3G BTS | 1. Signaltron 2. Signaltron 3. Fibcom |
| 13.2.3 Pico 3G BTS | 1. Signaltron 2. Signaltron 3. Fibcom |
| 13.2.4 Femto 3G BTS | 1. Signaltron 2. Signaltron 3. Fibcom |
| 14.1.2 Micro 2G BTS | 1. C-DOT 2. ITI |
| 15.1. Macro eNode B, Category 2, TEC ENB GR (TDD/FDD) | 1. C-DoT 2. Tejas Networks Ltd 3. Lekha Wireless 4. Resonous Technologies Pvt. Ltd. 5. VNL 6. Signalchip 7. Signaltron 8. VNL 9. HFCL 10. VVDN 11. Galore Networks 12. Cientra 13. Vista |
| 15.2 Micro eNodeB, Category 2, TEC ENB GR (TDD/FDD) | 1. C-DoT 2. Tejas Networks Ltd 3. Lekha Wireless 4. Resonous Technologies Pvt. Ltd 5. VNL 6. Sooktha 7. Signalchip 8. Signaltron 9. HFCL 10. Galore Networks 11. Cientra |
| 15.3 Pico eNodeB, Category 2, TEC ENB GR (TDD/FDD) | 1. C-DoT 2. Lekha Wireless 3. Resonous Technologies Pvt. Ltd 4. Sooktha 5. VNL 6. HFCL 7. SIGNALTRON 8. SIGNALCHIP 9. Airtel 10. JIO |
| 15.4 EPC (Enterprise class) | 1. TCS 2. TechMahindra 3. Tejas Networks 4. VNL 5. HCL 6. Resonous Technologies 7. Galore Network 8. Sooktha 9. galore Technologies 10. HFCL |
| 15.5 4G NIB Small cell | 1. C-DoT 2. Tejas Networks Ltd 3. Lekha Wireless 4. Resonous Technologies Pvt. Ltd 5. Sookhta 6. SIGNALCHIP 7. SIGNALTRON 8. VNL 9. HFCL 10. Galore Networks |
| 16.1.1. Wide Area eNode B, Category 1, TEC ENB GR (TDD/FDD) | 1. C-DoT 2. Tejas Networks Ltd 3. Lekha Wireless 4. SIGNALCHIP 5. SIGNALTRON 6. Galore Networks 7. UTL 8. ITI |
| 16.1.2. Medium range eNodeB, Category 1, TEC ENB GR (TDD/FDD) | 1. C-DoT 2. Tejas Networks Ltd 3. Lekha Wireless 4. SIGNALCHIP 5. SIGNALTRON 6. Galore Networks 7. UTL |
| 16.1.3 Local area eNodeB, Category 1, TEC ENB GR (TDD/FDD) | 1. UTL 2. Tejas Networks Ltd 3. Lekha Wireless 4. SIGNALCHIP 5. SIGNALTRON 6. Galore Networks |
| 16.1.4 EPC (Carrier class) (TEC EPC GR) | 1. Tejas Networks Ltd 2. TechM 3. CDoT 4. Galore Networks 5. UTL |
| 16.2.1 5G gNodeB (Base Station) including CRAN or DRAN or VRAN based architecture | 1. C-DoT 2. Tejas Networks Ltd 3. Sterlite 4. JIO 5. Wisig 6. SIGNALCHIP 7. SIGNALTRON 8. SOOKHTA 9. LEKHA WIRELESS 10. Saankhya Wireless 11. VVDN 12. UTL 13. BigCat Wireless 14. Galore Networks 15. HFCL |
| 16.2.2 5GC (Packet Core) - Carrier Class | 1. TCS 2. TechMahindra 3. HCL 4. JIO 5. Galore Networks 6. UTL 7. IITB 8. Valles Marineris 9. Elcom 10. WiSig |

| | |
|---|---|
| 16.2.3 5GC (Packet Core) - Enterprise Class | 1. TechM 2. UTL 3. Sooktha 4. Galore Networks 5. WiSig 6. Niral |
| 17.1 Indoor AP (802.11 ac MIMO, 2.4 & 5 GHz bands) | 1. MAKSAT Technologies Pvt. Ltd 2. TEJAS Networks Ltd 3. Inventum Technologies Pvt. Ltd. 4. Frog Cellsat 5. HFCL 6. Kenstel 7. Kirat Communications 8. SandsIndia 9. UTL Technologies 10. Digisol 11. C-DoT ToT: BEL 12. C-DoT ToT: ITI 13. C-DoT ToT: System Control 14. C-DoT ToT: RCV 15. VVDN Technologies 16. C-DoT ToT: KAYNES 17. C-DoT ToT: CYIENT 18. UTL 19. HFCL 20. Kenstel 21. VVDN Technologies 22. Indio Networks 23. Inventum Technologies |
| 17.2 Indoor AP (802.11 ac MIMO, 2.4 & 5 GHz bands) | 1. Tejas Networks Ltd 2. UTL 3. CDoT 4. ITI 5. BEL 6. Cyient 7. KAYNES 8. Aggressive 9. ELCOM 10. Kirat Communications 11. VVDN Technologies 12. Indio Networks 13. Inventum Technologies 14. Kenstel Networks 15. HFCL |
| 17.3 Outdoor AP (802.11ac - MIMO 2.4 and 5 GHz bands - IP67 Rated | 1. VNL 2. Kenstel Networks 3. Tejas Networks 4. VNL 5. Inventum Technologies 6. HFCL 7. UTL 8. BEL 9. CDoT 10. Kirat Communications 11. CYIENT 12. ECIL 14. ITI 15. SCTSPL 16. COMINT 16. TARANGG (MSME) 17. ELCOM 18, KAYNES 19. AGGRESSIVE 20. KENSTEL 21. Indiop Networks 22. VVDN Technologies |
| 17.4 Outdoor AP (802.11 n/b/g - MIMO 2.4 and 5 GHz bands - IP67 rated | 1. VNL 2. CDoT 3. Inventum Technologies 4. CYIENT 5. Kenstel 6. HFCL 7. Tejas Networks 8. VVDN Technologies 8. Indio Networks 9. HFCL |
| 17.A.1 Type 1: <= 2000 AP support | 1. KENSTEL NETWORKS 2. HFCL 3. Tejas Networks 4. CDoT 5. VVDN Technologies 6. Inventum Technologies 7. Indio Networks |
| 17.A.2 Type 2: >2000 AP support | 1. KENSTEL NETWORKS 2. HFCL 3. CDoT 4. Inventum Technologies 5. Indio Networks 6. VVDN Technologies 7. Tejas Networks |
| 17.B.1 Enterprise grade AAA Block (Radius) | 1. INDIO Networks 2. STL |
| 17.B.2 Carrier grade AAA block (Radius/ Diameter) | 1. INDIO Networks 2. STL |
| 18.1 Radio systems (IP/ Hybrid), Mobile Front haul BBU and RRH (CPRI, eCPRI, FlexE, RoE, NGFI) (<24 | 1. HFCL 2. Shyam Telecom 3. BEL 4. ECIL 5. Frog Cellcast |

| | |
|---|---|
| GHz band)) | |
| 18.1 Radio systems (IP/ Hybrid), Mobile Front haul BBU and RRH (CPRI, eCPRI, FlexE, RoE, NGFI) (<24 GHz band)) | 1. VNL 2. HFCL 3. CDoT 4. Saankya Labs 5. Data Patterns 6. VVDN Technologies 7. Kenstel Networks 8. BigCat Wireless |
| 18.2 Radio systems (IP/ Hybrid), Mobile - Front / Mid / Back haul BBU and RRH (CPRI, eCPRI, FlexE, RoE, NGFI) (52-71 GHz) | 1. KENSTEL NETWORKS 2. MMRFIC 3. UTL |
| 18.4 Radio systems (IP/ Hybrid), Mobile - Front / Mid / Back haul BBU and RRH (CPRI, eCPRI, FlexE, RoE, NGFI) (71-90 GHz)) | 1. Astrome Technologies (Multiple Point-to-Point E-band Radio) 2. UTL |
| Ruggedised handheld, Ruggedised or non-ruggedised vehicle mounts, P2P OR P2MP or Mobile adhoc topology, Licensed /Unlicensed band operation | 1. BEL 2. Saankhya Labs 3. Rolta 4. HFCL 5. Sanctum 6. Lekha Wireless 7. CYIENT 8. Makers Village Triaxon Technologies 9. BigCat Wireless 10. Data Patterns |
| 20. Repeaters (RF/RF-over-Optical), IBS and Distributed Antenna systems (indoor / outdoor) including Active & Passive Accessories | 1. Kavveri Telecom 2. Vensurwaves 3. Mymo Wireless 4. BEL 5. Shyam Telecom 6. VNL 7. UTL 8. UTL 9. Kenstel Networks |
| 21.1.1 VSAT Terminals Static, Transportable, On the Move (including IP Modem, BUC & LNB, Accelerator, along with antenna and accessories etc.)<br>C, L, S, Ku/Ka bands<br>SCPC<br>MF TDMA (DVB RCS, DVB RCS II)<br>(All bands up to 45 Mbps) | 1. Astrome Technologies (C,ku, Ka) 2. Saankhya Labs (All) 3. BEL (S, C, Ku) 4. Astra (All) 5. Alpha (All) 6. Essel Shyam 7. HFCL 8. Data Patterns 9. Decibel 10. MCBS<br><br>SCPC<br>1. Astrome (C, Ku - 45 Mbps; Ka - 100 Mbps) 2. Saankhya (C,L, S, Ku, Ka - 45 Mbps) 3. BEL (S, C, Ku 45 Mbps) 4. Alpha (All Bands 45 Mbps) 5. Astra (All Bands 45 Mbps)<br>MF TDMA<br>1. Astrome (C, Ku - 45 Mbps; Ka - 100 Mbps) 2. Saankhya (C,L, S, Ku, Ka - 45 Mbps) 3. Alpha (All Bands 45 Mbps) 4. BEL (S, C, Ku 100 Mbps) 5. Astra (All Bands 45 Mbps) |

| | |
|---|---|
| | |
| 21.1.2 VSAT Hub Equipment (including SSPA, LNA, Mod / De Mod), U/D Converter, Accelerator, NMS S/W, RF-Fibre converter, Antenna and accessories etc.) C, L, S, Ku, Ka Bands | 1. Astrome (C,ku, Ka) 2.Saankhya (All) 3. BEL (S, C, Ku) 4. Astra (All) 5. Alpha Design (All) 6. MCBS |
| 21.1.3 VSAT Terminals Shipborne (including Modem/BUC & LNB, Accelerator) along with antenna and accessories C, L, S, Ku, Ka Bands | 1. Astrome (C,ku, Ka) 2. BEL (C, Ku) 3. BigCat Wireless 4. MCBS 5. Saankhya Labs (L, S) |
| 21.1.4 VSAT Terminals Airborne (including Modem/BUC & LNB, Accelerator) along with antenna and accessories C, L, S, Ku, Ka Bands | 1. Astrome (C,ku, Ka) 2. Astra (All) 3. MCBS |
| 21.2.1 SCPC | 1. Astrome 2. Saankhya 3. BEL 4. Alpha 5.MCBS |
| 21.2.2 MF TDMA (Mesh) (DVB RCS, DVB RCS II) | 1. Saankhya 2. Astrome 3. BEL 4. AD 5. MCBS |
| 21.2.3 MF TDMA (Star) (DVB RCS, DVB RCS II) | 1. Saankhya 2. Astrome 3. BEL 4. AD 5. MCBS |
| 21.3.1 BUC | 1. Astra 2. AD 3. BEL 4. MCBS |
| 21.3.2 LNB | 1. Astra 2. MCBS |
| 21.3.3 Antenna | 1. Astra 2. AD 3. BEL 4. Astrome 5. MCBS |

| | |
|---|---|
| SSPA<br>RF U / D Conv<br>Mod / De Mod<br>LNA<br>Accelerator<br>NMS S/W<br>RF to Fibre Converter<br>Antenna and accessories etc. | 1. Astrome (C,ku, Ka) - Mod / Demod, Antenna, (NMS), U/D Convertor<br>2. Saankhya (All) - Mod / Demod, Accelerators, NMS<br>3. BEL (S, C, Ku) - Accelerator, Antenna, NMS, (Mod/ Demod)<br>4. Astra (All): Mod / De Mod, Accelerator, RFTs, (NMS S/W), Antenna, U/D Convertor, LNA (Ku)<br>5. Alpha Design (All): Mod / De Mod, RFTs, NMS S/W, Antenna<br>6. MCBS |
| C,Ka, Ku, L, S Bands | 1. Saankhya Labs Pvt. Ltd 2. HW Design Labs 3. Astrome Technologies 4. CDoT 5. MCBS |
| TEC GR (TEC / TS TP / TX / PVT -01/01/JAN - 11) for Portable Terminals Voice and Data (2 Mbps UL) | 1. BEL (Ku - 2 Mbps), (S - 9.6 Kbps) 2. Astra (S - 9.6 Kbps) 3. Saankhya (S) - support upto 2 Mbps 4. Alpha Design (C, Ku: 2 Mbps) - TEC GR 5. Aristrome (Ku - 2 Mbps) |
| Bands (L, S and Ku, *Ka* bands) | 1. Skylo Tech 2. Astrome Technologies 3. Saankya Labs |
| Satellite IoT devices for various applications position tracking, messaging etc. | 1. BEL -S Band 2. Saankhya - S Band (L Band under development)) 3. Alpha Digital( S Band) 4. Astra ( Sband) 5. WiwaNet (S Band) 6. Accord Software & Systems 7. Astrome Technologies 8. VVDN Technologies |
| Half-duplex and full-duplex modems, VSAT Modems, Mobile Satellite Service ( MSS) terminals, Satellite Phones (L band & S-band ), Satellite IoT devices | 1. Astrome Technologies 2. Data Patterns 3. Saankhya Labs 4. BEL 5. Alpha ((S band) 6. Astra (S Band) 7. WiwaNet (S Band) |
| Including Mod / De Mod) , Accelerator, NMS S/W etc., based on open standards | 1. Astrome 2. Saankhya 3. BEL 4. Astra 5. Alpha 6. MCBS |
| Satellite Broadcast receivers, IP receive only terminals, Portable messaging terminals, Location reporting terminals | 1. Saankhya Labs Pvt. Ltd 2. Avantel 3. BEL |
| Burst & Continuous Modems/ Demodems, TDM & Burst Modulators, Hub-NMS Software, IP Encryptors | 1. Saankhya Labs Pvt. Ltd 2. Avantel 3. BEL |
| Both Voice and Data (up to 9.6 Kbps) | 1. BEL (S Band) 9.6 Kbps 2. Saankhya (S Band) 9.6 Kbps 3. Astra (S Band) 4.8 Kbps 4. Alpha (S Band) 9.6 Kbps |
| Both Voice and Data (> 9.6 Kbps) | Linked to the satellite infra of Inmarsat. |
| 22. Copper access systems (DSL/ DSLAM), high-speed xDSL (G.fast) | 1. C-DoT 2. Pulse Communications Systems Pvt. Ltd. 3. Nomus 4. MRO tek 5. UTL |

| | |
|---|---|
| 23.1 Carrier class | 1. C-DoT 2. CYIENT DLM 3. Nivetti Systems Pvt. Ltd. 4. NMSWorks Software 5. TEJAS Networks Ltd 6. Sterlite 7. Coral 8. Redisys 9. UTL 10. Minadarray System 11. Everest IMS Technologies 12. Fibcom 13. VVDN Technologies 14. Galore Networks 15. Coral Telecom |
| 23.2Enterprise Class | 1.NMSWorks Software Pvt. Ltd. 2.Mindarray Systems 3.EverestIMS Technologies 4. Matrix Comsec 5. Nivetti Systems 6. Fibcom 7. CDoT 8. Galore Networks 9. Coral Telecom 10. Tejas Networks 11. Inventum Technologies 12. UTL 13. Galore Networks 14. VVDN Technologies |
| 24.2 Service Fulfilment system | 1. NMSWorks Software 2. Mindarray Systems 3. EverestIMS Technologies 4. Inventum Technologies 5. Galore Technologies |
| 24.3 Inventory Management | 1. NMSWorks Software 2. Mindarray Systems 3. EverestIMS Technologies 4. Inventum Technologies 5. Galore Technologies |
| 24.4 Geographical Information System (GIS) | 1.NMSWorks Software 2. Lepton Software Export & Research 3. NMS Works Software 4. BEL 5. Galore Technologies |
| 25. Security and Surveillance Communication Systems (video and sensors based) including Perimeter Security Systems | 1. VNL (Perimeter sensors) 2. HFCL ((Perimeter sensors) 3. BEL (Thermal cameras) 4. Samriddhi Automations Pvt limited 5. CP Plus 6. Matrix Comsec Pvt. Ltd. 7. Zelotic (Hyderabad) 8. Videonetics 9. Sparsh Technologies 10. Cron Systems 11. Matrix Comsec 12. Makers Village Tranzmeo 13. Saankhya Labs 14. VVDN Technologies 15. MCBS 16. Lekha Wireless |
| 25.1 Dual Sensor PTZ Camera | 1. BEL 2. MCBS 3. Samriddhi Automations Pvt. Ltd 4. VVDN Technologies |
| 25.2 M2M Remote Management Portal | 1. Sensorise Digital Services 2. MCBS |
| 25.2 Aerial Security System using autonomous RPA | 1. PDRL 2. MCBS |
| Optical Fibre; Single Mode / Multimode | 1. Sterlite Technologies Limited 2. Birla Furukawa Fiber Optics Limited 3. Finolex cables limited 4. Himachal Futuristic Communications Limited 5. Teracom Limited 6. HTL Ltd |
| 26.2.1 Overhead | 1. Sterlite Technologies Limited 2. Birla Furukawa Fiber Optics Limited 3. Finolex cables limited 4. Himachal Futuristic Communications Limited 5. Teracom Limited 6. Aksh Optical 7. Paramount Cable 8. E-Systemizer 9. AdhishwarTelenetworks 10. HTL Ltd 11. Polycab India Pvt. Ltd 12. Pratap Digital Communications 13. Pranav Enterprises 14. Universal Cables Ltd 15. Vindhya Telelinks Ltd 16. Villet Communications 17. ITI Ltd. 18. Makers Village Tranzmeo IT |

| | |
|---|---|
| | solutions |
| 26.2.2 Underground | 1. ITI 2. Many from 26.2.1 |
| 26.2.3 Submarine | Many from 26.2.1 |
| 26.2.4 Accessories | Many players |
| 27.1 UPS, Power Plant, Invertor (Including Solar Power) 0.5-1500 KVA | 1. Vikram Solar 2. Waaree Solar 3. Goldi Green Technologies Pvt.. Ltd. 4. Tata Power Solar Systems Ltd. 5. Loom Solar 6. Moser Baer Solar Limited 7. XL Energy Limited 8. Solar Semiconductor 9. Emmvee Photovoltaics Private Limited 10. Navitas Green Solutions Pvt.. Ltd. 11. Saatvik Green Energy 12. Panchavaktra Power 13. Invendis Technologies India Pvt. Ltd 14. VNL 15. Exide Industries Ltd 16. Amara Raja Batteries Ltd 17. Luminous Power Technologies Pvt. Ltd 18. HBL Power Systems Ltd 19. Su-Kam Power Systems Ltd 20. Base Corporation Ltd 21. Okaya Power Ltd 22. Southern Batteries Pvt. Ltd 23. True Power International Ltd 24. Evolute Solutions Pvt. Ltd 25. Greenvision Technologies Pvt. Ltd 26. Artheon Electronics Ltd 27. UTL 28. CDoT 29. BEL 30. VNL 31. ITI |
| 27.2 Power Plant: (Modular) | 1. BEL 2. UTL 3. ITI |
| 28.1 Telecom Batteries (Lead Acid) 250-5000 AH (Including VRLA) | 1. Exide 2. Amarraja |
| 28.2 Li-Ion Batteries | 1. UTL 2. BEL |
| 29. IP audio phones / IP video Phones / Analog adaptor | 1. Coral Telecom 2. Kenstel Communications Pvt. Ltd. 3. Pulse Communications Systems Pvt. Ltd. 4. Matrix Comsec 5. Elcom Innovation ltd. 6. CDOT 7. Matrix Comsec 8. BEL 9. Coral Telecom |
| 30. SDN Software Controllers, NVF and CNF software | 1. Inventum Technologies Pvt. Ltd 2. Nivetti Systems Pvt. Ltd. 3. IIT Chennai 4. DRDO CARE 5. TEJAS Networks Ltd 6. Lavelle Networks Pvt. Ltd. 7. Cosgrid 8. Nubewell 9. Sanctum 10. UTL 11. Nivetti Systems 12. CDoT 13. Saankya Labs 14. WiSig |

| | |
|---|---|
| 31.1 Spine Switches ( 10G/25G/50G/100G interfaces) | 1. Yotta 2. CtrlS 3. NetMagic 4. Bharati Airtel 5. ESDS 6. NxtGen 7. Sify 8. TCL 9. RailTel 10. Jio 11. NIC 12. Nivetti Systems 12. CDoT 13. Saankhya Labs 14. ITI |
| 31.2 Top of Rack Switches ( 10G/25G/50G/100G interfaces ) | 1. C-DoT 2. Nivetti Systems 3. ITI |
| 32. 2 way Analog/ Digital radio including Walkie-Talkie & Mobile Radio | 1. TalkPro 2. Trucom 3. BEL 4. Sanchar Communications System 5. VNL 6. DSP Works |
| 33. Batteries of 2 way Analog/ Digital radio including Walkie-Talkie | 1. Eon Electric Ltd 2. Future Hi-Tech Batteries 3. Sanchar Communications Systems 4. BEL |
| 34.1 OTDR - RTU Single / Multi Fibre; | 1. Sterlite Technologies Limited 2. Birla Furukawa Fiber Optics Limited 3. Finolex cables limited 4. Himachal Futuristic Communications Limited 5. Inventum Technologies Pvt. Ltd 6. Nivetti Systems Pvt. Ltd. 7. CDOT 8. BITCOM TECH 9. NMSWorks Software 10. Andig Systems |
| 34.2 Remote Fibre Monitoring & Testing System (Software) | 1.NMSWorks Software 2. CDoT |

| | |
|---|---|
| 35.1 M2M/ IOT Subsystems including NB IoT in different verticals | 1. Azoi (Health Technology) 2. Cooey (Healthcare) 3. Car IQ (Automobile Analytics) 4. Altiux (Smart Homes) 5. Enterox (Cloud and Big Data) 6. Wireless Controls 7. Uncanny Vision (Embedded System) 8. Light Metrics (Connected Trucks) 9. Things Cloud (Smart Energy) 10. SAAR Microsystems Industrial IoT (Connected Devices) 11. Mango Man (Smart TV) 12. Knowledge Lense (Big Data) 13. PluggX Lab (Smart Homes) 14. RHL Vision (Robotics) 15. Transpose India (Traffic Data Analytics) 16. Algo Engines (Smart Electricity) 17. Machine Pulse (Big Data and Analytics) 18. Mobilloitte Sensors (IoT ExSmart Wearable) 19. Inventrom (Cloud Platform) 20. Altizon (Smart Manufacturing) 21. Entrib (Industrial IoT) 22. Maven System (Smart Metering) 23. Senz IT (Digital Documentation) 24. UBER Diagnostics (Medical) 25. WiSIG 26. DSP works 27. Sensorize 28. VNL 29. ELGEN (smart lighting) 30. Green IP Core (water sensors) 31. Lefe9 systems 32. Asimov Robotics Pvt Ltd 33. Brain Wired (livestock monitoring) 34. Cavalier Wireless (Cellular IOT modules) 35. Enspark Systems (Home automation) 36. Fayette innovation (wearable devices) 37. Nimo technologies (wearable devices) 38. Nyokas Technologies (intelligent textile systems) 39. VaugnFrayr Luminaires (smart lighting) 40. wioopikings Pvt Ltd (hardware IoT modules) 41. Sookhta 42. GreenPCore 43. DSP Works (Lora, Sensors, Utility Metering, Indus IOT, Home Automat.) 44. EIGEN Technologies (Smart Light, Energy, Metering) 45. CDoT 46. Sensorise Digital Services (M2M connectivity and Lifecycle management 46. Mannash 47. EverestIMS Technologies 48. Galore Networks 49. Makers Villagr Cavli Wireless 50. Frogcellsat 51. Dyotis 52. Enmovil 53. WiSig 54. VVDN Technologies |
| 35.2 Customer Feedback Device, Portal and Analytics | 1. Eigen Technologies (SENSEnuts) + Many from 35.1 above |
| 35.3 M2M Security Client & Platform | 1. Eigen Technologies (SENSEnuts) + Many from 35.1 above |
| 35.4 M2M Remote Management Portal | 1. Eigen Technologies (SENSEnuts) + Many from 35.1 above |
| 35.4 Multi-Protocol IoT Gateway | 1. Eigen Technologies (SENSEnuts) 2. Enmovil 3. Many more from 35.1 above |
| 35.5 Multi-Protocol IoT Headend | 1. Eigen Technologies (SENSEnuts) + Many from 35.1 above |
| 35.6 Vehicle Tracking and Alarms Management | 1. SenseGiz 2. Many more from 35.1 above |

| | |
|---|---|
| | |
| 36. Enterprise GSM, VoIP | 1. Dialtronics 2. Matrix Comsec 3. Inventum Technologies Pvt. Ltd 4. TEJAS Networks Ltd 5. Nivetti Systems Pvt. Ltd. 6. Frog Cellsat 7. Dialtronics 8. CDOT 9. BEL 10. Coral Telecom |
| 37.1.1 nano: less than or equal to 250g; | 1. Makers Village-Ai Aerial Dynamics 2. MCBS |
| 37.1.2 micro: greater than 250g and less than or equal to 2g; | 1. PDRL 2. Makers Village-Ai Aerial Dynamics 3. MCBS |
| 37.1.3 small: greater than 2kg and less than or equal to 25kg; | 1. PDRL 2. MCBS |
| 37.1.3 small: greater than 2kg and less than or equal to 25kg; | 1. Makers Village-Ai Aerial Dynamics 2. MCBS |
| 37.1.3 small: greater than 2kg and less than or equal to 25kg; | 1. UAVE Limited 2. Makers Village-Ai Aerial Dynamics |
| 37.1.4 medium: greater than 25kg and less than or equal to 150kg; and | 1. UAVE Limited 2. Makers Village-Ai Aerial Dynamics |
| 37.1.5 large: greater than 150kg. | 1. UAVE Limited 2. Makers Village-Ai Aerial Dynamics |
| 38. Including Web camera /IP camera /Thermal camera /Dome camera /Bullet camera /Indoor & Outdoor camera /Smart, voice integrated cameras | 1. VNL 2. Sparsh 3. VVDN 4. Smriddhi Automations Pvt Ltd 5. Sansap Technology Pvt Ltd 6. Matrix Comsec 7. Fibcom 8. BEL 9. HW Design Labs (OPC) 10. Radio Product Companies 11. Accord Software 12. VVDN Technologies 13. MCBS 14. CP Plus 15. ENMOVIL |

| | |
|---|---|
| 39. Telecom Billing Support System (BSS) with all its derivatives | 1.NMSWorks Software 2.Sterlite Technologies Ltd. 3. Alepo Technologies 4. Inventum Technologies 5. CDoT |
| 40. Video Conferencing Applications | 1. Coral telecom 2. Dbaux Technologies Pvt. Ltd 3. C-DoT 4. IIT Roorkee 5. MeitY companies under hackathon 6. BEL 7. VVDN Technologie 8. MCBS |
| 41.1 Troposcatter antennas | 1. KENSTEL NETWORKS 2. Frogcellsat |
| 41.1 Line of Sight (LoS ) antennas (Pt-Pt & Pt-Multi Pt) | 1. Astrome Technologies 3. Data Patterns 4. UTL 5. VVDN Technologies 6. Lekha Wireless |
| 42 Satellite Communication- Ground/ Earth Station Antennas | 1. Astrome Technologies 2. BigCat Wireless |
| 43. Lawful Logging Platform - IPFIX, Syslog, CG-NAT, NAT logs, etc. | 1. Inventum Technologies Innovative Solution |
| 44. CAP based Early Warning Platform for Disaster situations | CDOT Innovative solution |
| 45. Deployment of Private Cloud | 1. BEL 2. VVDN Technologies |
| 46. GNSS based Time Servers (including navIC) NTP. IEEE 1588/PTP for Time Synchronisation and Standalone GNSS receiver for location information | Accord Software & Systems (Innovation at Global level) |
| 47. Conditional Access System for Broadcast networks | CDOT Innovative solution |
| 48. Point of Sale Device | BEL Innovative Solution |
| 49. Digital Rights Management (DRM) | CDOT Innovative solution |
| 50. PKI Token | BEL Innovative Solution |
| 51. Indigenous prototype development for Indoor bi-directional communication based on Li-Fi technology with maximum data rate support | BEL Innovative Solution |
| 52. Secure Chat and Call Platform | CDOT Innovative solution |
| 53. Quantum Key Distribution (QKD) | 1. C-DOT 2. DRDO 3. QNU labs are also working on QKD) |
| 54. G3I Based NTP/PTP Time Reference Server | BEL Innovative Solution |

| | |
|---|---|
| 55. DMR ( Digital Mobile Radio in UHF & VHF band) | BEL Innovative Solution |
| 56. AAA & TACACS appliances for smart cities | 1. Inventum Technologies Innovative Solution |
| 57. C band+ L band optical amplifier | 1. UTL 2. MCBS |
| 58. 5G Channel Recorder and Spectrum Analyzer | BigCat Wireless innovative Solution |
| 59. Pre-fab shelter for BTS/Exchanges | 1. PRIMA TELECOM LTD 2. Kenstel Networks |
| 60. 5G Core Testing Tool | Cientra Innovative Solution |
| 61. 5G NAS STACK deployment on IOT Devices make them 5G Capable | WiSig (Innovation at Global level) |
| 62. Cloud-native 5G Edge networking platform for Enterprises | WiSig (Innovation at Global level) |
| 63. 5G Satcom | WiSig (Innovation at Global level) |
| 64. Integrated back haul 5g relay systems | WiSig (Innovation at Global level) |
| 65. mm Wave Systems | 1. WiSig 2. Astrome |
| 66. Mobile Phone for Broadcast Signals | Saankya Labs (Indian innovation for global innovation) |
| 67. NB-IoT Geo Satellite Systems | WiSig (Innovation at Global level) |
| 68. NB-IoT Skylo Hub | WiSig (Innovation at Global level) |
| 69. Solutions for home, enterprise, office automation, other applications of IoT modules with secure cloud access | 1. DSPWorks 2. Life9 System 3. NS Electrosecure 4. Vighanharta Technologies |
| 70. Wi-Fi, LoRa, 802.15.4g, NBIoT based modules that are used with various applications in sectors of power, automotive, home, enterprise | 1. DSPWorks 2. Life9 System |

| | |
|---|---|
| 71.1. Portable Footing-based Towers / Masts for 4G/5G<br>71.2. Skid-based Towers / Masts for 4G/5G<br>71.3. Cell on Wheels (COWs) for 4G/5G<br>71.4. Rooftop Towers / Masts for 4G/5G<br>71.5. Poles for 5G<br>71.6. OFC Junction Chambers & Manholes | 1. Kotkar Energy Dynamics 2. Salasar Technologies 3. Precision Electronics |
| 72.1 Macro RU | 1. VVDN technologies 2. HFCL 3. STL 4. Tejas 5. Saankya Laba |
| 72.2 Indoor RU | 1. VVDN technologies 2. HFCL 3. STL 4. Tejas 5. Saankya Laba |
| 73. 5G CPE | 1. VVDN technologies 2. HFCL 3. STL 4. Tejas |
| 74.1 Over-the-Air Technology (SIM & Device Management) | 1. Mannash (Innovation at Global level) with Right to Use award to Airtel |
| 74.2 On Demand SIM Activation (White Labelled SIM Card) | 1. Mannash (Innovation at Global level) with Right to Use award to Airtel |
| 74.3 SIM Based Roaming Steering, Mobile ID, Quality of Service, Emergency/Presidential Alerts | 1. Mannash (Innovation at Global level) with Right to Use award to Airtel |
| 74. Drone Communication | Botlab Dynamics, Start-up by IIT-D team and many Startups have known capabilities (Botlab Dynamics demostrated through 1000 Drones in Beating retreat function) |
| 75. Infrastructure Monitoring System (Software and Hardware (RTU) deployed for monitoring & controlling Telecom Infra like Tower Sites, Point of Presence (POPs), Submarine Cable Landing Stations (CLS), etc from a Central Location.) | 1. NMSWorks Software (Innovation at Global level) 2. Sensorise |
| 76.1 Flow based Threat Detection using AI/ML<br>76.2 Firewalls | 1. Nivetti Systems<br>2. Gajshield |
| 77. IP PBX | 1. Matrix Comsec 2. Coral Telecom |
| 78. Customer Premises Media Gateways | 1. Matrix Comsec 2. Coral Telecom |
| 79. VoIP and SIP Phones | 1. Matrix Comsec 2. Coral Telecom |

| | |
|---|---|
| 80. PLCC Switches | 1. Matrix Comsec 2. HFCL |
| 82.1 Secured OTP System to avoid frauds (Software in SIM and Server) | 1. Mannash (Innovation at Global level) with Right to Use award to Airtel |
| 82.2 Non OTP Based Secure authentication | 1. Mannash (Innovation at Global level) with Right to Use award to Airtel |
| 83. Card Operating Systems and Apps | Sensorise & Others |
| 84. Remote Management | Sensorise & Others |
| 85. IoT Data Management | Sensorise & Others |
| 86. Common Service Layer Platforms | Sensorise & Others |
| 87. IoT Device | Sensorise & Others |
| 88. IoT Device | Sensorise & Others |
| 89. IoT Security | Sensorise & Others |
| 90 IP TV | MCBS and others |
| 91. Mesh network of Hardware, Cloud, analytics and Software | SenseGiz Technologies (Global Innovation) |
| 92. ORAN7.2x/support 4G/5G/NB-Iot | 1. Saankhya Labs + Other 5G players |
| 93. Portable RAN framework for DU to make it hardware agnostic | 1. Saankhya Labs + Other 5G players |

## 2. White Paper on Market Access

# White Paper on Market Access

Public Procurement (Make in India) Policy, PPP MII is an excellent policy and has the potential to resurrect the domestic manufacturing industry.

**Following support is required to ensure ground level implementation:**

1. **Issue Frequently Asked Questions (FAQ) response document** for smooth implementation & interpretation of the policy in the desired spirit. FAQ has been reviewed by DOT but its pending to be published on website. FAQ was based on decisions, viewpoint and judgments taken in grievance redressal committee meetings at DOT / DPIIT. This paper must bring clarity on the following
   - Applicability methodology on Turnkey projects (big Govt buy) that includes large amount of civil work: Insistence that SI / EPC contractors must purchase at least 3a items where DOT has confirmed that capacity and competence exists in the country.
   - Imported proprietary (in contrast to standard computing platforms) hardware with peripheral software like" billing" or configuring or NMS or integration cannot be shown as DVA. Similarly Profit, AMC, Installation cannot not be part of DVA.
   - Policy circumvention in the name of up-gradation or additional licensees for old systems (even 10–15-year-old systems) must be addressed considering spirit of the policy.
   - Circumvention of policy in the garb of Inter-operability with old proprietary products.
2. **Restart the grievance re-addressal meetings** as was the case before Corona. This would address several industry concerns and Govt buyers get sensitized.
3. As in the 2017 policy of DOT, **Insist on compliance to TEC specifications in all tenders for Telecom products.** Tenders must ask for TEC protocols and standards defined for any inter-operability with third party devices or for meeting any functional requirements. This is important because frivolous specifications or functional requirements are inserted to circumvent the system. Customers may get TEC specs revised / upgraded after public consultation which provides time to the industry to adapt & update. Such proactive mechanism will safeguard against Indian industry being put in "chasing mode" for every tender.
4. **Enhance the list of items under 3a to include all items manufactured locally.** There is a list of 61 items that were submitted and is now part of updated Public Procurement Notification as being submitted in parallel. These products are manufactured in India and must be supported.

5. Myth that 60% domestic VA is not possible must be broken since balance sheets of most big companies will show raw material consumption in manufacturing process being less than 50% of the sale value. They operate at more than 50% Gross contribution otherwise they wouldn't even meet their expenses. If total raw material for them is 50% then active components and ICs cannot be more than 25% of the sale price so the myth that domestic VA cannot be 60% till semiconductor fabs are set up need to be busted in the mind of decision makers.

6. **Domestic Value Addition (VA) should be enhanced from the VA percentage specified in 2017 policy of DOT.** Sufficient manufacturers were meeting those criterion & competing for the tenders. As a community we cannot make retrograde claims on VA percentage. Telecom products are security sensitive and unlike consumer electronics design and IPR component is high which must be given high weight age. Design and designing is the cornerstone to ensure absorption of technology in the country and to ensure downstream ecosystem for industrialization and employment generation in India.

7. **Portals like GEM to be more sensitive to VA percentage declared by sellers**.
   - They allow foreign products showing 21% VA without proper verification. May be profit or installation or AMC is shown as DVA. Many of the imported products are declared as Class I by the bidders.
   - Tenders insist on all products from one OEM. Indian SME's may not have all the subsystems required for a project hence is left out.
   - None of the procuring agency follow a protocol to get waiver from Standing committee or Secretary Coordination as per DPIIT guidelines to get Make in India policy exemption. Many of the PAC RFP/tenders are there on GEM wherein foreign Make and models has been sought even if equivalent domestic products are available. GEM should not allow publishing of such a product even if overall Value Addition is met.

8. **Enlarge the scope of the policy to Include**
    - State Governments purchases.
    - Purchases by Telecom operators.
    - World bank funded projects at least for 3a products
    - Indian projects undertaken in other countries against LOC or Grant in Aid.
9. **Implementation agencies responsible for ensuring policy compliance should be given more teeth to ensure punitive action against defaulters both at buyer end as well as sellers making wrong declarations.** Situations exist where buyers ignored the directions of the standing committee meeting responsible for implementation of PPP MII order.

10. **Enforcement and surveillance of Govt Initiatives like MTCTE and Trusted Sources at ground level**

- MTCTE phase 1 and phase 2 has been implemented since more than a year and now phase 3 and phase 4 has been announced. Still, many of the products for which MTCTE is not available or are kept in abeyance are being imported, implemented by many of the TSP/ISP or traders. There are companies who have spent lot of effort, time, and money to get their equipment certified, unless MTCTE surveillance is enforced at ground level implementation of non-trusted inferior/second-hand products will continue.

- Trusted Source is a good initiative by Govt of India to ensure only secure products are being implemented by Indian TSP and ISP as soon as the agency starts giving clearances for the source/products, the enforcement of the same is must.

# 3. White Paper on USOF activities through Direct Award/

# Direct Tender through a new class of USOF Project awardee
# (beyond Licensed Service Provider at Circle Level)

**White Paper on USOF activities through Direct Award/ Direct Tender through a new class of USOF Project awardee i.e. beyond Licensed Service Providers at Circle level**

1. **Can we have USOF Project coming with a License Award or Direct Award/ Direct Tender for the area covered (cluster for villages and not limited to Circle level licensee)?**

2. **Can this license mandate existing licensees in the State to offer Reference Offers to new USO licensees (players) on:**

   a. **Shared Spectrum resources for 3 to 5 years period based on reference offers from existing state licensees**

   b. **USOF licensee installs his equipment including Wi-Fi, Radio, Satellite and mobile equipment for providing coverage in select cluster of villages.**

   c. **USOF licensee can provide his own Billing and Customer Service facilities.**

   d. **Shared Network resources (active and passive) based on a reference offer from existing State level licensees with terms approved by TRAI**

   e. **Mandatory Interconnect facilities with existing licensees at the State level so that calls from these cluster of villages can be routed to any part of the world.**

f. **USOF licensees thus covers many CAPEX elements to OPEX**

g. **He can provide better QoS as compared to existing licensees in the state as he has control on his equipment and model works better than MVNOs**

h. **Dependence on the USOF project on existing state level licensees ends.**

i. **The problem of tens of thousands of villages with no coverage presently and their endless wait and being at mercy of existing licensed players' end.**

**Model will support small players to directly implement the USOF projects using their own equipment independently**

# 4. White Paper on recent USOF tender for the Aspirational Villages

# White Paper on recent USOF tender for the Aspirational Villages

1. **USOF tender for the recent Aspirational Villages**

   **a.** USOF floated tender for 4G based Mobile Services in identified uncovered villages of Aspirational Districts in the states of Andhra Pradesh, Chhattisgarh, Jharkhand, and Odisha.

   **b.** Although the tender calls for compliance to DOT's PPP-MII Order 2017, it does not specify list-item wise compliance of Local Content as prescribed in DOT's PPP-MII Order. Similarly, compliance to TEC GR, as prescribed in DOT PPP-MII Order 2017, has not been made mandatory.

   **c.** A fool-proof mechanism should be established to ensure the compliance of prescribed LC limited as per DOT PPP-MII Order 2017.

   **d.** Like TSEC by BSNL QA, Testing & certification by TEC/ TSEC, or any accredited lab by TEC, must be made as a mandatory requirement to avoid any circumvention of the policy. The products approved by TEC/ TSEC only should be allowed to be deployed in the network being funded by USOF.

   **e.** The current approach to circumvent government policies was also used by USOF in LWE-II as well as NER tender for mobile services where imported equipment is being deployed by TSPs who have started implementation.

   **f.** Technical team involved in tender clearance at every stage tried to dodge when the issues were raised by forums through DPIIT. These projects as are in initial stages and implementation has not yet started and there is a need to re-look into the equipment proposed for deployment as these networks are being funded by USOF. TSPs should be told to deploy TEC GR approved products complying to PMI guidelines of value addition as per prescribed list.

2. **Non-Compliance TEC GR in USOF projects**

   **a.** USOF tenders floated in last few years for provision of mobile services do not involve intentionally any TEC specifications for equipment to be used.

   **b.** None of these tenders, as well as currently in process tender asked for TEC GR approved products. Clearly showing how the government policies are circumvented openly by the government officials intentionally themselves and wrong justifications are being given when the issue is raised through DPIIT.

   **c.** All these tenders should be relooked for compliances as per PMI policy which was asked in tender for compliance by TSPs.

| | Scheme Name | Tender No | Date |
|---|---|---|---|

| | | | |
|---|---|---|---|
| | Provision of mobile services in 354 uncovered villages | DDG (Spl.Projects) / USOF/ Uncovered/2018-19 | 17.1.2019 |
| | Provision of mobile services based on 4G technology in identified uncovered villages A&N Islands | USOF/TENDER/ ANI/30-174-7/ 2015-USO-BB (Vol.XII) | 08.05.2020 |
| | Provision of 4G based mobile services in identified uncovered villages in aspirational Districts | USOF/TENDER/ Aspirational Districts /1/2020 | 19.05.2020 |
| | provision of 4G based mobile services at MHA identified tower locations in Left Wing Extremism (LWE-II) affected areas | USOF/TENDER/LWE-II/ 30-164/2020 | 11.03.2021 |
| | 4G based mobile services in identified uncovered villages & along NHs of Meghalaya | USOF/TENDER/MEGHALAYA/30-252-7/2019 | 10.02.2020 |

3. **Exclusion of Domestic companies in the USOF tenders**

**a.** Despite having applicability to PPP-MII Order in USOF tenders, all the last many projects have been awarded to Private TSPs and equipment supplied by foreign MNC companies.

**b.** None of the domestic equipment vendors could get an opportunity to supply the equipment, despite have competence and ability to supply where intentionally tender requirements are tweaked to promote foreign products.

**c.** The USOF states that the tenders are service based tenders based on Viability Gap Funding (VGF) and the actual deployment of products is the responsibility of the bidder. As per extant DIPP guidelines including PPP Projects and VGF schemes funded by USO shall be governed by compliance to Public Procurement Guidelines.

**d.** The PPP-MII Order policy has been circumvented in these tenders as no one in USOF certifies technically that products deployed on site fulfils the PMI guidelines as per tender and are Indian products which shows intention of promoting foreign products. Recently ongoing USOF projects under implementation can be scrutinized to refute the claim made by us.

4. **Outstanding payments from BSNL**

**a.** The industry through various industry associations request intervention of DOT and Finance Ministry for regular payment by PSUs like BSNL.

**b.** We have observed the outstanding payments declared by BSNL, as we understand, are only CAPEX payments, whereas huge OPEX outstanding is pending for payable with BSNL from respective circles. This is increasing on a QoQ basis and the vendors finding it difficult in cashflow.

**c.** In case of LWE Phase I, the vendors doing the O&M activity have O&M outstanding to the tune of Rs. 200 Crs since last more than 1 year but the data is not transparently shared and projected in any forum despite repeated reminders at CMD level

5. **Classification of HS Codes and Imposition of BCD**

**a.** With the advancements in telecom sector globally and convergence of multiple technologies, many new products / solutions have been evolved.

**b.** These new products have not been properly classified under the HS Code Classifications and hence are being imported under “Others” or “Parts” categories to bring in zero duty BCD structure.

**c.** A detailed study should be undertaken by the DOT and concerned ministries to identify the new generation products to allocate specific HS Codes. Those new generation products for which domestic industry-built competence, requisite BCD should be imposed to provide level playing field to the domestic industries while competing with foreign products.

6. **Manufacturing Definition**

Defining the manufacturer of telecom equipment should be properly formalized by government to provide benefits to Indian manufacturers. We propose that the company which is having its R&D registered from DSIR should only be categorized as manufacturer. The basic philosophy of the suggestion is based on analogy that if a company is having R&D in India, it will have full control on any product it is moving into i.e., from inception to design to control all variants to components and then assembly of those components to deliverable products.

It should be clearly separated from the assemblers who either copy the foreign products to assemble the look alike products to sell in India or do assembly of foreign products where design rights are with outside Indian companies.

All government incentive schemes to promote knowledge-based economy should be given to manufacturers to create knowledge base which will encourage more and more startups and innovations.

7. **Indian Product:**

Like defining the Indian manufacturer, efforts should be made to define category of Indian product from imported designs assembled in India. This will pave way for custom authorities to impose duties which will be in line with government vision of AtmaNirbhar Bharat.

The fully imported product or components going into assembly of that product in India can be put under duty to further promote innovation in India and create more and more Indian products.

8. **Recommendation**

**1.** All government project funded by USOF/DoT should be implemented through BSNL only as government money should be used to create assets of government only.

**2.** BSNL should implement the project using only Indian Designed and Developed products complying to relevant TEC GRs.

**3.** The product specifications should be finalized for open tender thr a committee where TEC person should also be a member for properly guiding as which relevant GR should be used in which scenario.

**4.** Domestic manufacturers should be asked to present the solution thru presentation/POC to showcase the working solution to maximize the participation of Indian industry into nation development.

**5.** Government should mandate TEC GR based requirements for next 2-3 years prospective projects so that Indian Industry gets time to develop products based on government opportunities and enough competition can be created.

# 5. REVIVAL OF LAST MILE CONNECTIVITY USOF (BHARATNET) PROJECTS UNDER PPP Mode

**REVIVAL OF LAST MILE CONNECTIVITY USOF (Bharatnet) PROJECTS UNDER PPP Mode**

1. **7 Domestic companies in mid-2019 had submitted proposals on last mile connectivity under USOF Project. These were submitted along with ITI.**

    a) **Lekha Wireless,**
    b) **Saankhya Labs,**
    c) **Nivetti Systems**
    d) **Resonous,**
    e) **Signal Chip,**
    f) **Sookhta,**
    g) **Aristrome**

    **There were more submissions from Tejas Networks, VNL etc also/**

**2. All proposals of similar nature can now be revived under PPP mode and VoICE Paper 11 methodology can be starting point. Fine tuning and modifications can be done under guidance of USOF Administration.**

**3. Annex A and B have submissions made by Lekha Wireless and Saankya Labs. There were similar submissions by other 5 through ITI and by Tejas Networks and VNL though others.**

**ANNEX A**

**Lekha Wireless**

**Proposal for Pilot Project for 4G Network for personal mobile broadband in rural areas as part of BharatNet with USOF funding**

**Part A**

IDENTIFICATION

1. **Title of the Pilot Deployment:** 4G Network for personal mobile broadband as part of last mile connectivity of BharatNet.

2. **Specific Area of Pilot Deployment:**

   We would like to deploy 4G LTE network in GPs identified by USOF. Preferred state for the pilot deployment in state of Karnataka / Tamilnadu / Andhra Pradesh within 150Kms around Bengaluru.

3. How does the pilot fit into the objective of the scheme ie., "reap the benefit of innovation and strategy for better utilization and improved service delivery to the citizens by utilizing BharatNet"?

   Lekha Wireless is technology company based out of Bengaluru incorporated in 2010. We have developed a range of wireless communication products involving technologies like 4G and WiMAX. The 5G products are under development.

   Below are salient points with respect to Innovation and strategy for extending the BharatNet coverage till the last mile.

   - The product is based on popular access technology **LTE standard**, enables mass deployment in the next phase of the project.

   - **Coverage area** of 5 km per eNodeB for a typical rural deployment scenario. The User end devices can be any commercial off the shelf LTE devices like any smart phones and low-cost LTE routers.

   - Proposed technology provides advantage with respect to coverage, **ubiquitous connectivity** and mobility compared to WiFi. The connectivity for the users of the network is no longer limited to a hotspot in the village.

   - Each sector can have a **capacity** of 200 mbps/ 100 mbps respectively for FDD and TDD system with 20MHz channel BW. Proposed deployment is any of the popular LTE bands in the country for example Band 41, Band 40, Band 3, Band 1 or Band 5. The capacity can be

further extended by a factor of 2 as part of carrier aggregation feature on the same HW as part of software upgrade roadmap.

- **User density** of 1000 users per cell and up to 100 active users are supported. Compared any other technology that provides point to point connectivity LTE has huge cost benefit for connecting such large number of users in the last mile.

- Inhouse developed technology includes hardware and software stacks enables complete ownership for manufacturing and long maintenance of the network. Lekha works with local contract manufacturing to build the base stations and we can enable local companies to take care network maintenance enabling true objective of **Make in India** vision**.**

- **Modular & SDR** architecture for the low power portion of the system. This enables small turnaround for building / tuning the product for different frequency band support and power levels with changes absorbed only on the high power RFE module.

- Scalable Platform and Software based radio enables easy **roadmap** all the way up **to 5G**.

- Embedded Radio for easier Installation & Management of the eNodeB equipment at site.

Highly efficient radio amplifiers and design approach makes Lekha eNodeB very power efficient. The design allows long hours of operation with battery back up which is important for rural area.

4. **Duration :** 10 months which includes 3 months observation period.

   Refer to the detailed project plan below.

5. **Total Project Cost** 10 Crores

6. **Name of the Applicant** Lekha Wireless Solutions Pvt Ltd.

7. **Name of concerned Civic authority** ITI Limited, Bengaluru

8. **Capability of the organization/Individual**

   a. Available expertise with the applicant

   Lekha is OEM of 4G eNodeB equipment. The technology used for both HW and Software are indigenously developed. Lekha has expertise of deploying the 4G network for special

purposes like Private network for industrial automation and tactical communication networks along with partner's core network.

b. List of ongoing and completed projects/pilot deployments

| Project Title | Start Date | Completion Date | Pilot Project Deployment cost | Sponsoring Agency/Customer |
|---|---|---|---|---|
| Development of LTE based eNodeB and UE | November 2017 | June 2021 | Supply of LTE eNodeB and UE for tactical network. 11 cores | BEL Bengaluru. Project obtained through tendering. |
| iDEX challenge LTE LAN on Naval ships of Indian Navy. | October 2019 | September 2019 | 3.2 crores | Atal Innovation Mission, DIO, Niti Aayog |
| Deployment of LTE Private network in CBRS band | January 2020 | TBD | Done in partnership mode. Cost TBD | Ondas Network Inc USA. |

**Part B**

1. **Brief description / Background about the organization/ Institution**

   Lekha Wireless Solutions Pvt Ltd is a Self-funded Indian private limited company registered under companies act and based out of Bengaluru. Founded in 2010 by Amarnadha Reddy and Ramu Srinivasaiah with a vision to be best-in-class solution provider in the areas of Wireless Communications systems and Embedded Systems. Since inception, Lekha has been focusing on Technology development and R&D to bring out home grown Products in the areas of WiMax, 4G LTE and 5G Technologies. With a team strength of 170 Engineers, Lekha holds several IPRs in the 5GNR, LTE & wireless domain and has published several articles in this area.

2. **Background of the problem which pilot project Addresses**

We understand that government has successfully connected fiber optic connectivity up to the Gram Panchayat (GP) Level. This pilot Project envisages much need wireless voice and data connectivity from the GP to the common man in the villages thereby digital empowerment in the Rural areas. Lekha Wireless has extensive experience in wireless development and has brought out innovative products & Technologies in this area proposes to take up this Pilot Project under this USOF scheme. A detailed Proposal is here with enclosed as an Annexure 2. After implementing this Pilot Project with 128 active users and 1000 registered users, a village user will be able to get a data rate of up to 1 Mbps.

3. **Description of Pilot Deployment**

a. Objectives of the pilot deployment

The Aim of this Pilot Project is to provide reliable personal mobile broadband services to smart phone users and government institutions in remote villages of the country which includes voice & data communication.

b. Preliminary investigation done by Organization/Individual

We understand from our discussions with USOF officials and study of materials available on USOF web site here are our submissions

- BharatNet reaches today mostly about 28% of the urban population and the objective is to reach 72% rural population which are still not connected.
- The village institutions for eg., schools, health centers, post office, police station etc are potential beneficiaries of the last mile connectivity of BharatNet.
- The data consumption over the last 3 years on BharatNet is expanding at the rate of 40% per annum.
- There are about 1.25 Lakh GPs across the country are connected to respective Block with a dedicated BharatNet fiber with 1 gbps link as part of BharatNet Phase II.
- The Phase II of BharatNet combination of Underground Fiber+ Aerial Fiber+ Wireless Backhaul + Satellite Back haul.
- The target is to complete the connectivity to all 2.5Lakh GPs in the country.

Lekha wireless intend to deploy one eNodeB per GP there by covering all the villages institutions and citizens within the coverage range of 4 to 5 kms around the GP. For more detail of the proposed network architecture can be found in the Annexure 2. Lekha's proposed network provide an opportunity to extend the BharatNet to end users through 4G/LTE technology which provides personal mobile broadband connectivity wirelessly.
Preferred state for the pilot deployment is in the state of Karnataka with proximity to Lekha's work location Bengaluru. This will help us reducing the logistic overheads.

c. Domestic Component in the Pilot Deployment

| Sl No | Component | Home Grown? | Comments |
|---|---|---|---|
| 1 | PHY Layer Software | Yes | Design and IP ownership. |

| | | | |
|---|---|---|---|
| 2 | L2 and L3 Software | Yes | Design and IP ownership. |
| 3 | High power RF design | Yes | Design ownership |
| 4 | Baseband HW design | Yes | Design ownership |
| 5 | Mechanical and electrical design. | Yes | Design ownership |
| 6 | Semiconductor components like SoC and radio components | No | Imported. |
| 7 | Antenna, Cables and accessories. | No | Commercially of the shelf items procured locally. |
| 8 | Core network | No | Sourced from other Indian partner companies. |

d. Linkages

Below diagram shows the network element and activities at various locations in order to deliver the network.

**State Headquarters** **Zone** **Block** **GP** **Village**

*Need to install NMS, And EPC here*

*Setup eNodeBs and antenna here*

*Issue SIM cards*

Below are linkages to other organization in delivering the services

d.1) Internet services from BhartNet – BBNL/BSNL?

d.2) Space and provisions at NoC to setup server for installing the EPC and NMS. - BBNL

d.3) Installation of eNodeB at the GPs. This require necessary permission to put up the towers. Provision for electricity and space for equipment like eNodeB, power supply etc at the site. Require support from USOF.

d.4) Support for installing the LTE routers in 2 government building per village. Issue of provisioned SIM cards for valid users.

d.5) Permission and support for integrating the eGovernance application to the network. Service providers like CSC?

e. Other organizations working in this area

The 4G RAN products are being supplied by both domestic and international players.
Other Domestic Players

a) Resonous

b) Sooktha

c) Signal Chip

d) VNL

e) CDOT

f) Tejas

Popular International players are

a) Ericsson

b) Nokia

c) Huawei

d) ZTE

e) Samsung

f. Methodology: Detailing stepwise activities and sub-activities

f.1) Cell Site identification

f.1.a) Identification of coverage area.

f.1.b) Perform RF survey.

RF survey is conducted to determine the cell sites.

f.1.c) Identify the cell sites for the coverage area.

Cell sites are identified, and planning is performed. Frequency planning if applicable needs to be performed at this stage.

f.1.d) Determine the height of the mast and trigger the site preparation activities.

f.2) Installation and Commissioning

f.2.a) Installation of EPC.

Install the EPC at the central location. The EPC will have connectivity to all the cell site eNodeBs. Confirm that the EPC can communicate to the internet gateway.

f.2.b) Installation of eNodeBs at identified cell sites

Install the eNodeB at the site.
Install the Antennas at the tower top.
Route the RF cables from the eNodeB base band unit to the antenna.

f.2.c) Commissioning of the eNodeBs

Power ON test of eNodeB.
The eNodeB will be updated with the appropriate software and configurations and will be monitored for any alarms.
Return Loss (RL), VSWR etc. will be verified.
The antenna positions will be adjusted based on the feedback from RF Survey.
Other commissioning activities to make sure that the network is live.

) Coverage verification

a) Drive tests

Drive tests are performed to verify the coverage in different locations and data is collected.

f.3.b) KPI Analysis

Analysis and optimization of key performance indices.

4. **Work Plan**

Phase-wise plan for action up to post pilot deployment activities detailing time schedule, milestones may clearly be indicated. PERT/GANTT may be attached.

| Sl No | Activity Detail | Start | End | Comments |
|---|---|---|---|---|
| 1 | Signing of MoU with USOF | T0 | | Considered as start of the project |
| 2 | Ordering components | T0 | T1= | The activity will be |

| | | | | |
|---|---|---|---|---|
| | and trigger manufacturing of equipment. Produce integrated and tested unit. | | T0+16 weeks | completed with fully tested equipment ready for deployment |
| 3 | Identification of sites frequency planning and site survey. | T0 | T2=T0+6 weeks | Planning for site preparation done. |
| 4 | Site Preparation | T2 | T3=T0+12 weeks | Ordering, shipping of site equipment to erect towers, cabling etc. |
| 5 | Transportation equipment | T1 | T4=T0+20 weeks | Antenna installed on all the towers. |
| 6 | Installation and commissioning | T4 | T5=T0+26 Weeks | Complete installation and commissioning at all sites. |
| 7 | Start operations. Includes connectivity validation, integration of EPC and EMS. Provisioning of SIM cards. All other preparation to start the service. | T5 | T6 = T0+30 Weeks | End of this activity the monitoring period can be started. |
| 8 | Monitoring Period | T6 | T7 = T0 + 42 Weeks | 3 month observation period. |
| 9 | Training and handover of network. | T7 | T8 = T0 + 48 weeks. | This includes training and handholding ITI for maintenance. |
| 10 | End of support period | T6 | T9 = T6+53 Weeks | 1 year support from the launch of services. |

5. **Outcome of pilot deployment**

After implementing this Pilot Project, 20 GPs will be installed with complete Base stations. A 4 to 5 km ubiquitous wire 4G coverage will be established in each of these GPs with 1000 registered Users and 128 concurrent users for each of the GPs with a road map for extending the user density to 300 users on the same HW. With this, total area covered will be (75Sq Km X 20GPs) 1500 Sq Km with 15000 active users and 1800 concurrent users. The Users will experience a personal Broadband, roaming with a shared bandwidth of up to 100 Mbps for each of the GPs.

- The Proposal covers comprehensively the following:
- Supply of Base station along with the Core Network with associated Antenna & Cables including Power System (UPS &Solar Power)
- SIM Management, billing & Network management
- Services covers Supply of equipment to the field, Installation, Testing & Commissioning, Maintenance during the observation period and maintenance of the network up to 1 year.

6. **Likely Impact [Social/Economic]**

- Voice, Video and data services to citizens in village over the smart phone and other LTE devices.
- The proposed pilot project clearly brings out opportunity for delivering of existing eGovernment services ubiquitously over mobile platform like cell phones of citizens in the villages within coverage area around the GP. The proposal includes integration of IP network to application servers of CSC (common service centers) for e-Governance applications.
- The Proposal is comprehensive in providing the 4G network for rural broadband including the model of revenue generation through VLEs (Village level Entrepreneurs).
- Disaster alert system integrated over 4G network.
- Roadmap Features that can be delivered as software upgrade
    - TV broadcast over the LTE network,
    - position server and direction of arrival to provide position of each user in the network.
    - NB - IOT network which can enable largely agricultural automation.

7. **Parameters for monitoring effectiveness of Pilot Deployment**

- Number of villages connected.
- Average number of users in the network
- Additional use cases added if any.
- Equipment up time
- Cost comparison in achieving the connectivity.

- Amount of data traffic
- Comparison with other technology in existing BharatNet for last mile connectivity.
- Power consumption and efficiency of the 4G network.

8. **Suggested post pilot deployment activities.**

- Lekha is committed to offer extended warranty or AMC beyond 1 year at the rate of 12% of the equipment cost per annum.
- We expect USOF to consider the companies with successful trails for other bigger USOF projects on nomination basis.
- Lekha is committed to upgrade the software to add necessary bug fixes and features as part of maintenance.

**ANNEX B**

**Saankhya Labs' Fixed Wireless Point to MultiPoint Connectivity Solution for Pilot Project for Utilization of BharatNet under USOF**

# 2. Part A – Identification

## A.1. Title of the Project

**Saankhya Labs' Fixed Wireless Point to MultiPoint Connectivity** Solution based on IEEE 802.22 standard for Pilot Project for Utilization of BharatNet under USOF.

## A.2. Specific Area of Pilot Deployment

Saankhya Labs (SL) recommends executing this Pilot in Rural Bengaluru, Karnataka. Specific villages will be identified after the project approval. Based on the outcomes of the RF survey, we shall recommend other locations as well.

## A.3. How does the Pilot fit into the Objective of this Scheme

Saankhya Labs provides a 100% indigenous Fixed Wireless Access (FWA) product based on a global standard, the IEEE 802.22, designed specifically for Rural Broadband Connectivity. The product is designed, developed & manufactured in India including the baseband chip which is the heart of the system.

This best in class, innovative solution can be used to increase the usage of BharatNet and enable easy deployment of broadband services to the villages that are located beyond the Gram Panchayats where there is zero connectivity, at present. Our Fixed Wireless Solution can facilitate online classes and can also enable Broadband Connectivity to unconnected village institutions like Schools, Primary Health Centers, Community Health Centers, Post Offices, Anganwadis, Police Stations, etc…

It provides robust long-distance wireless broadband connectivity to remote areas without digging/laying underground cables.

### A.3.1 Uniqueness and Innovation of Saankhya's Fixed Wireless Point to Multi-Point Solution

- SL's FWA (Fixed Wireless Access) products are India's first FCC certified Fixed Wireless Access Solutions.
- SL's FWA products are designed and developed in India, including the main Baseband Processor, which is based on a Saankhya Labs patented Software Defined Radio (SDR) chip.
- SL's FWA products are the world's first IEEE 802.22 standard compliant WiFAR technology product. Competing FWA vendors' equipment are based on proprietary protocol which are not interoperable with other vendor products.
- Works in the UHF band (470-698 MHz). Operates in Non-Line of sight. Better Penetration through foliage. Long range communication (upto 15 Kms).

- Field upgradable and remote management of equipment through Element Management System (EMS).
- Suitable for sparsely populated rural India where coverage, costs and power considerations are important.

## A.4. Duration

The entire project duration including supply of equipment, installation & commissioning and trial will be no more than one year.

This detailed project plan will be optimized during the project planning phase.

## A.5. Total Project Cost

The complete cost of the project as per the detailed scope defined in Part B is Rs. 9.99 Cr.

## A.6. Name of Applicant

Saankhya Labs Pvt. Ltd.

## A.7. Name of Concerned Civic Authority

ITI Limited, Bengaluru.

## A.8. Capability of Organization / Individual

### A.8.1 Expertise Available with the Applicant

Saankhya Labs is a Chipsets to Systems Company for 5G Broadcast, 5G Broadband and Satellite Communications products based on Saankhya's patented Software Defined Radio (SDR) semiconductor technology. Saankhya Labs is India's first fabless semiconductor company with the world's first production SDR.

Saankhya Labs has **30 international** patents including 5 Standard Essential Patents covering NextGen "6G" RAN and convergence. Saankhya Labs, in partnership to ISRO, provides satcom & terrestrial communications solutions for the Indian Army.

Saankhya Labs' solutions include industry's first IEEE 802.22 compliant Fixed Wireless Access systems for rural broadband connectivity, satellite communications modems for IoT applications and multi-standard DTV modulators and demodulators.

Some of Saankhya's solutions that are deployed in the field are –

- S-Band Locomotive Tracking System for the Indian Railways, including a two-way MSS terminal for tracking of locomotives to enable Real Time Information System (RTIS) of Indian Railways and corresponding

hubside Equipment.

- S-Band Vessel Tracking System for the Indian Navy, including a two-way MSS terminal for tracking shipping vessels and fishing trawlers at deep sea and corresponding hubside Equipment.
- S-Band Satellite Mobile Radio Terminal device designed to operate with ISRO's GSAT Satellite Network.
- Broadcast Radio Head (BRH) for NextGen Digital Terrestrial Transmission (DTT), deployed with a Tier-I operator in the US.

### A.8.2 List of Ongoing and Completed Projects / Pilot Deployments

The following table is a list of ongoing & completed Projects / Pilot Deployments for SL's Fixed Wireless Access products.

| Sr. N | Project Title | Start Date | Completion Date | Project / Pilot deployment | Sponsoring Agency |
|---|---|---|---|---|---|
| 1 | IIT Delhi | Aug 29, | Sep 04, | 676,9 | IIT, |
| 2 | IIT Varanasi | Feb 03, | Feb 10, | - | Saankhya |
| 3 | IIT Srikakulam | Mar 29, | Mar 31, | - | Saankhya |
| 4 | IIT Mumbai | Apr 14, | Apr 25, | - | Saankhya |
| 5 | IIT Hyderabad | May 09, | May 18, | - | Saankhya |
| 6 | University of Illinois, US | May 09, | May 14, | 3,032,420 | University of |
| 7 | JP Systems Corporation, | Jun 05, | Jun 25, | 1,374,304 | JP Systems |
| 8 | Microsoft Corporation, | Jun 20, 2018 | Jul 05, 2018 | 737,000 | Microsoft |
| 9 | TEVET Llc | Jul 16, | Jul 25, | 1,625,4 | Tevel |
| 10 | Africom, Zimbabwe | Feb 22, | May 17, | 763,8 | Africo |
| 11 | Citek, South Africa | Apr 05, | Jun 15, | 916,4 | Citek |
| 12 | Mobile DST, South Korea | Aug 20, | Dec 20, | 613,200 | Mobile DST |
| 13 | EMS Rotoura, NZ | Jan 05, | Mar 25, | 265,2 | EMS |

# 3. Part B – Details of the Project

## B.1. Brief Description/Background about the Organization/Institution

### B.1.1 ITI Limited

ITI Limited, is a PSU under the Ministry of Communication in the field of Telecom Manufacturing
& Services (Turnkey Solution Provider). After serving the country (DoT, BSNL, MTNL, Indian Army, Indian Airforce etc.) in the field of Switching, Transmission, Terminal Equipment & Networking, presently, ITI is handling the following tasks.

- Design, Manufacturing and Implementation of Secrecy devices for Indian Defense Networks (DCN, NFS etc.)
  - Laying of OFC for NFS
  - Bharat Net Projects
- Maintenance of ASCON Phase III Network for Indian Army; going to implement ASCON Phase IV Mega Network
  - SWAN Projects
  - Maintenance of 2G & 3G Mobile Networks
  - NGN (Triple Play)
  - GPON
  - Smart Energy Meter
  - Data Centre
  - Smart cards, RuPay & Mastercard
  - Mini PCs
  - Solar Panel Manufacturing
  - Setting up Wi-Fi networks for BSNL/BBNL
  - TAG ITI Wallet
  - Face Mask for Covid-19

### B.1.2 Saankhya Labs

- Saankhya Labs is a communication solutions company that provides communication products based on its award winning, patented Software Defined Radio (SDR) SoC platform. Saankhya Labs offers a wide range of communication products for applications in broadband, satellite and broadcast communications. With several international technology patents and unique 'chips-to-systems' expertise, Saankhya Labs' solutions include industry's first IEEE 802.22 compliant Fixed Wireless Access solution for rural broadband connectivity, satellite communications modems for IoT applications and multi-standard DTV modulators and demodulators. Saankhya Labs is working on creating cutting edge technology in NextGen TV and communications solutions for 5G and beyond.
- Saankhya Labs is driving "Make in India" in electronics design and manufacturing

and has
invested 100+ Cr to develop solutions that power rural broadband initiatives like “Digital

India" and indigenous defense communication equipment. The company is widely recognized in the semiconductor industry as a pioneer in Software Defined Radios and Cognitive RAN and has several international patents and IPRs in this space. These technologies are key elements for the "Network of the Future".

- Saankhya Labs is also a technology partner for ISRO and has designed indigenous Satellite phones and SDR manpack solutions for the Indian defense sector.
- Saankhya Labs has 30+ international patents including Standard Essential Patents and several awards to its credit. The company is headquartered in Bangalore, India.

## B.2. Background of the Problem which the Pilot Project Addresses

Gram Panchayats (GP) are connected to the Internet under the BharatNet program. However, BharatNet is under-utilized as many sparsely populated villages are located at a distance from the GPs, service provisioning is restricted, due to the time taken and costs incurred to lay fiber to these remote villages. Coverage area of WiFi installed in the GP is limited to ~50 – 100m from the Wifi hotspots which are typically installed at the GP. The average number of users per GP is quite low. In addition, the sparse population in these remote villages creates a very difficult business case for laying the fiber to these villages.

Newer, innovative & indigenous wireless technologies are now available to circumvent these limitations and ensure faster service delivery to subscribers in sparsely populated remote villages. This will increase the usage of BharatNet.

## B.3. Description of Pilot Deployment

### B.3.1 Objectives of the Pilot Deployment

The objectives of the pilot are

a. Bring reliable network access to 264 villages
b. Increase the utilization of BharatNet
c. Demonstrate wireless connectivity using Saankhya Labs' Fixed Wireless Access products

The pilot aims to connect GPs to villages using an innovative wireless communications technology designed, developed and manufactured entirely in India using the UHF spectrum from 470 to 698 MHz. This pilot will cover 66 GPs and 264 villages.

ITI and Saankhya Labs propose an IEEE 802.22 (WiFAR) based solution to provide broadband access to rural areas, which otherwise remain unconnected to the rest of the world due to the lack of affordable broadband infrastructure.

The deployment architecture uses the novel concept of FWA technology as a back-haul or middle- haul network to extend the broadband connectivity from GP to remote villages with last mile access, using WiFi Hotspot. Users can then use personal devices like phones, tablets or laptops to access the internet and use other CSC services.

This project is a pilot and not a technology demonstration. Saankhya Labs' Fixed Wireless Access technology trials have been successfully concluded at IIT-D, IIT Hyderabad and IIT Bombay, and internationally in USA, Scotland, New Zealand, South Korea, South Africa, etc. using indigenous equipment. This project will showcase all Digital India's services at an affordable price. Its endeavor is to provide a template for speedy mass scale deployment through domestic manufacturing.

### B.3.2 Preliminary Investigations done by the Organization / Individual

The Benefits of Fixed Wireless Access solution from Saankhya Labs are multi-fold

a. Laying optical fiber is an expensive & time-consuming process which requires obtaining approvals for RoW, digging, laying ducts, permissions from the local utility companies & governing authorities, etc. Post laying of these cables, the operations & maintenance of these optical fiber cables require skilled labor & expensive tools for splicing. In contrast Saankhya Labs FWA solution enables infrastructure deployment as well as operations & maintenance without extensive digging.

b. Across many countries, a technology called Fixed Wireless Access over UHF spectrum is being used to provide internet access in rural areas. The UHF spectrum from (470 to 698 MHz), traditionally reserved for terrestrial TV transmission is under-utilized in India with only one or two 8-MHz channel being used by Doordarshan. The main advantage of this UHF frequency range in 470 to 698MHz band is that even at a very low power, signals propagate across long distances using small tower heights, compared to other technologies that operate at 900, 1800 or 2400MHz. This is beneficial for rural broadband.

c. The signals travel long distances due to the excellent propagation characteristics of electro- magnetic (EM) waves in the UHF band. As a result, we require a fewer number of installations to cover a given geographical area. This leads to lower CAPEX and lower OPEX.

d. Smaller towers/poles that are used decreases the setup cost because a simple pole made of 2.5inch GI pipe is sufficient (i.e. total height of 20-30 feet above ground level for user side equipment and 30-50 feet above ground level for Base Station). An existing cellular tower can be reused at the back-haul location.

e. Fewer towers are required and therefore the setup cost is lower.

f. Extremely low op-ex due to low power consumption.

g. Local manpower can be trained for easy installation, maintenance and speedy deployment.

### B.3.3 Domestic Component in Pilot Deployment

The 4 main components of this solution are Designed, Developed & Made in India.

Detailed specifications of the FWA BS & CPE are included in B.9 Annexures.

1. **Meghdoot Base Station SLB802ODU** - Long range wireless broadband access to subscribers over UHF spectrum.

- Achieves long range up to 15 km
- Supports non-Line of Sight (non-LOS) and Line of Sight (LOS) operation in both point to point (PTP) and point to multi-point (PMP) topologies
- Fixed wireless broadband solution
- Operates in TDD (Time Division Duplex) mode
- Maximum aggregate data rates of 25Mbps (8MHz) and 20Mbps (6MHz)
- Database support based on leading database providers
- Support both bridge and router modes of operation
- Both centralized and local device management using Saankhya's Element Management
- System solution
- EMS for ease of operation and remote monitoring and installation
- User Authentication and security using WPA2-PSK with AES-128 encryption
- FCC Certified Base Station (FCC ID -2AUUC-MEGHDOOT)

*Figure 1 Meghdoot Base Station*

## 2. Omni Antenna Specification

| Electrical Specifications | |
|---|---|
| Frequency Range | 470 – 698MHz |
| Gain | 6dBi |
| Horizontal Beam Width | 360° |
| Vertical Beam Width | 17°± 2.5° |
| Polarization | Vertical |
| Nominal Impedance | 50 Ω |
| VSWR | ≤ 1.8:1 |
| Input Power | 50W |
| Side Lobe Level | ≥ 10 dB |
| Connector | N Female |
| **Mechanical Specifications** | |
| Dimension (L) | 1550 mm |
| Radome Diameter | 40 mm |
| Total Mass | < 1.5 Kg. |
| Radome Material | PVC |
| **Environmental Specifications** | |
| Temperature Range | -20°C to+70°C |
| Wind Load | 120 Kmph |

*Figure 2 Omni Antenna for Base Station*

**3.** **Dhaval CPE Modem SLC802ODU** - Long range wireless broadband access to subscribers over UHF spectrum.

- Achieves long range up to 15 Kms
- Supports non-Line of Sight (non-LOS) and Line of Sight (LOS) operation in both Point to Point (PTP) and Point to Multi Point (PMP) topologies
- Fixed wireless broadband solution
- Support for TDD (Time Division Duplex) mode
- Maximum aggregate data rates up to 25Mbps (8 MHz) and 20Mbps (6MHz)
- Database support based on leading database providers
- Support both bridge and router modes of operation
- Both centralized and local device management using Saankhya's Element Management System (EMS) Solution
- EMS for ease of operation and remote monitoring and installation
- User Authentication and security using WPA2-PSK with AES-128 encryption
- FCC Certified CPE Modem (FCC ID -2AUUC-DHAVAL)

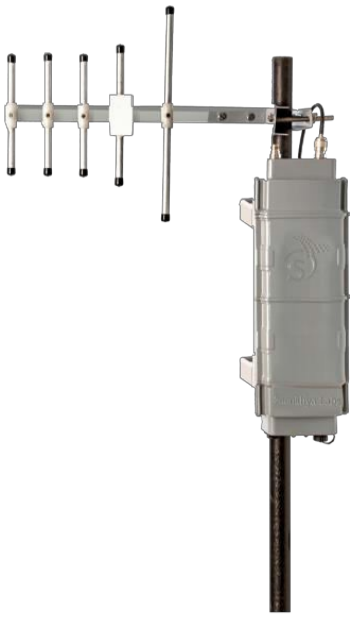
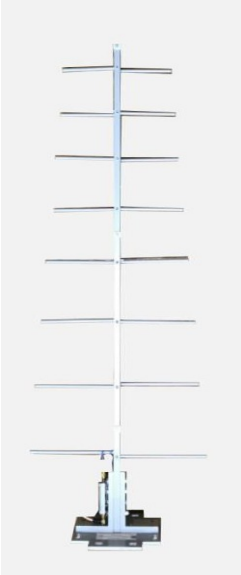


*Figure 3 Dhaval CPE*

## 4. Yagi Antenna Specification



| Electrical Specifications | |
|---|---|
| Frequency Band | 400-698 MHz |
| Impedance(ohm) | 50 |
| Gain | 9dBi |
| Polarization | Vertical |
| Radiation | Directional |
| VSWR | 2:1 |
| Horizontal Beam Width | >50 deg |
| Vertical Beam Width | >80 deg |
| Out of band Rejection | >15 dB to 40 dB |
| Max. Input power | 10 W |
| Output Cable | SMA (M) |
| **Mechanical Specifications** | |
| Antenna Material | Aluminum |
| Diameter | 1240x350x140 mm |
| Color | Gray |
| Weight | < 2.5 Kg |
| **Environmental Specifications** | |
| Operating temperature (°C) | -50～80 |
| Wind Load | 115 Kmph |

*Figure 4 Yagi Antenna for CPE*

### B.3.4 Linkages

1. Saankhya Labs is a Wireless Communication Semiconductors and Solutions Company. The Base Station (BS) & Customer Premise Equipment (CPE), recommended for this Pilot project, are made in India. These products are based on Saankhya's patented Software defined Radio (SDR) semiconductor technology.
2. ITI will be the Services partner, viz. Installation & Commissioning, Support, etc. They will also be provider of other equipment & accessories like Outdoor Wifi AP, WLC, poles, Masts, Solar Plant, UPS, Battery, etc.
3. Backhaul connectivity at the Base Station location to be provided by USOF.
4. Spectrum required for this pilot is to be provided by USOF. The requirements are as specified in the table below.

| Start Freq | End Freq | Center Freq |
|---|---|---|
| 534 | 542 | 538 |
| 542 | 550 | 546 |
| 550 | 558 | 554 |

In conclusion, we require 3 channels of 8 MHz each, i.e. a total of 24 MHz.

5. AMC for all equipment to be issued as a separate project budget.

### B.3.5 Other Organizations working in this area

1. Adaptrum
2. Whizpace
3. Runcom

## B.3.6 Methodology: Detailing stepwise activities & sub-activities

### B.3.6.1 Deployment Architecture

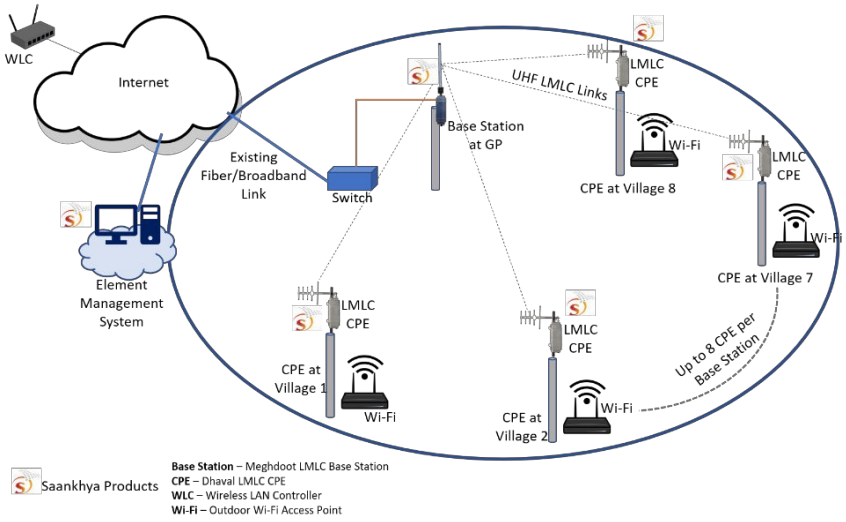



*Figure 5 Solution Architecture*

A single 8Mhz bandwidth base station provides a maximum of 25mbps*. With 1:3 frequency reuse, the setup needs 24MHz of bandwidth allocation for this pilot project. With this, a single Base Station (BS) per GP can provision up to a maximum of 8 villages with an omnidirectional (omni) antenna. The number of CPEs per BS can be configured depending on the wireless user contention ratio and the actual bandwidth required at each village. Outdoor WiFi access point will be connected to each CPE to provide wireless connectivity to users in the village. A Wireless LAN Controller (WLC) will be deployed in the cloud which helps provide control functions to each WiFi Access Point.

### B.3.6.2 Base Station setup at Gram Panchayat (GP)

At each GP, Internet Leased Lines are terminated. These provide a Point-of-Presence on an electrical or an optical port. A CAT6 cable from this port will be connected to the Base Station Equipment mounted on a tower up to a height of 30-50 ft. above ground level (AGL). The height of the tower is determined by inputs received from Radio planning activity. A Base Station will be connected to its antenna, mounted at the same point on the tower. In some cases, multiple sectors may be required if the number of villages to be served are more than the capacity of the Base Station depending on data rate. A Directional/Sector or Omni Antenna may be used, depending on the angular spread of the target villages around the Base Station. Directional/Sector antenna may also be used to ensure low interference with other Base Stations that are either co- located or at an adjacent location.

### B.3.6.3 CPE setup at Village

Base Station will communicate with the CPE installed in the villages using UHF spectrum. The CPE will feed a WiFi Access Point creating a WiFi Hotspot within its neighboring area of 100-200m. End-users can then connect to the internet through these hotspots using their WiFi enabled smartphones or using tablets/laptops installed at the Common Service Centers/Schools, etc. We can connect a maximum of 8 CPEs to each BS. Assuming there are 25 simultaneous users, each user can get 1Mbps. Assuming a contention ratio of 1:10, at least 250 users per GP will be online. In order to provide greater coverage within a village, a WiFi mesh network can be setup. A light weight Yagi antenna will be used for the CPE equipment.

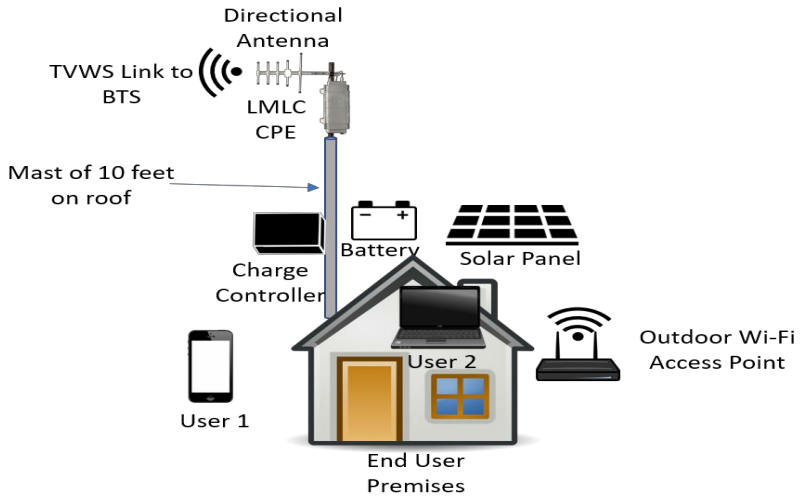



*Figure 6 CPE Modem side User Connectivity*

### B.3.6.4 Provisioning and Management of Fixed Wireless Access Equipment

The Element Management System can be operated from a Network Operations Center (NOC) or a data center on the internet to monitor, diagnose or configure the Base Station and CPEs.

### B.3.6.5 Power Supply

Power is supplied to the Base Station and CPE Modem over Ethernet cable using a PoE (Power Over Ethernet) Injector from an SMPS power supply unit. The CPE and Base Station can be powered entirely by an adequate solar power system. The typical power consumption of Base Station and CPE is 25W.

### B.3.6.6 Special Requirements to execute the project

Permission is required from WPC (Wireless Planning and Coordination) for use of UHF spectrum (between 470-698 MHz) within the geographical area of this project. For the present requirement, it is recommended to use a single band of 8-MHz per radio link

(For Higher Bandwidth requirements we will need additional multiples of 8MHz channel to provide incremental 25 Mbps links). With 1:3 frequency reuse the setup needs 24MHz of bandwidth allocation for this pilot project.

## B.4. Work Plan

The project plan shown below is a high-level project plan. A detailed project plan with all the milestones will be made after the USOF Project approval.

## B.5. Outcome of the Pilot Deployment

1. Ability to connect more villages which are otherwise not connected to the internet.
2. More users on BharatNet.
3. Our Fixed Wireless Access solution can facilitate Online Classes to enable distance & safe learning, which is extremely important post Covid-19 lockdown.
4. Benefits of wireless connectivity to the selected Schools, Primary Health Centers, Community Health Centers, Post Offices, Anganwadis & Police Stations.

## B.6. Likely Impact (Social / Economic)

As per Government of India study- “every 10% usage of Internet in India drives up GDP by 3.3%”

## B.7. Parameters for Monitoring Effectiveness of Pilot Deployment

1. Number of villages connected.
2. Traffic Utilization on BharatNet
3. Increase in use cases (Modern Farming, Tele Medicine, Smart Classes, etc)

## B.8. Suggested Post Pilot Deployment Activities

These activities are suggested for future scope of the Pilot Project -

a. Operations & Maintenance of the sites.

b. Annual Maintenance Contracts for all equipment for Fixed Wireless Access Equipment, solar plant, EMS, Leased Lines, etc. beyond 1 year.

c. Customer support.

d. Service delivery – Addition of new sites, etc…

e. Government of India should certify the effectiveness of the Indigenous technology for rural applications and recommend this technology/solution for Large scale deployments by bulk manufacturing in India.

f. Addition of 5G Broadcast solution to Fixed Wireless Access for improved Social Messaging, Digital Schools, Modern Farming programs, etc…

## Part C – Pilot Project Estimates Summary

| S. | Item | Per Unit Rate (INR) | Quant | Item Cos | GST 18 | Tolat Cost Including GST (INR) |
|---|---|---|---|---|---|---|
| **A. Equipment cost** | | | | | | |
| **A.** | **Base-Station side** | **# of GPs** | **60** | | | |
| A.1 | UHF Wireless Base Station (BS), one for every 4* villages | 163,000 | 60 | 9,780,000 | 1,760,400 | 11,540,400 |
| **A.** | **CPE side** | **# of villages (assumed** | **240** | | | |
| A.2 | UHF Wireless CPE Modem (CPE) | 75,500 | 240 | 18,120,000 | 3,261,600 | 21,381,600 |
| **A.** | **Monitoring and Management Tool** | | | | | |
| A.3 | Saankhya Element Management System (License fee, hosting, maintenance Fee) | 2,100,000 | 1 | 2,100,000 | 378,000 | 2,478,000 |
| **A.** | **Training, Installation support** | | | | | |
| A.4 | Training for Installation & Commissioning, Project Management and Remote Support | 3,900,000 | 1 | 3,900,000 | 702,000 | 4,602,000 |
| **A.** | **Antenna, Cables and Accessories** | | | | | |
| A.5 | Antenna (Omni) | 14,000 | 60 | 840,000 | 151,200 | 991,200 |
| A.5 | Antenna (Low power Yagi) | 9,500 | 240 | 2,280,000 | 410,400 | 2,690,400 |
| A.5 | Cables and Accessories | 2,500 | 300 | 750,000 | 135,000 | 885,000 |
| **A.** | **Annual Maintenance Contract** | | | | | |
| A.6 | RF Survey, RF Plan and Remote Support | 4,000,000 | 1 | 4,000,000 | 720,000 | 4,720,000 |
| | The above costs include warranty for 1 year. Any additional support & maintenance required for beyond the Warranty period of 1 year will be charged additionally as AMC at 12%. | | | | | |
| | **Total Budget for Saankhya Labs** | | | **41,770,0** | **7,518,6** | **49,288,6** |
| | **OTHER Equipments to be Sourced** | | | | | |
| **B.** | **WiFi Access related** | | | | | |
| | Wireless LAN Controller (WLAN) | 30,000 | 5 | 150,000 | 27,000 | 177,000 |
| | Outdoor WiFi Access Points | 20,000 | 300 | 6,000,000 | 1,080,000 | 7,080,000 |
| **B.** | **Poles/ Masta** | | | | | |
| B.2 | Poles for BS per GP (6m) ** | 10,000 | 45 | 450,000 | 81,000 | 531,000 |
| B.2 | Mast for GP (30m) ** | 200,000 | 15 | 3,000,000 | 540,000 | 3,540,000 |
| B.2 | Poles for CPE (2-3m) ** | 5,000 | 240 | 1,200,000 | 216,000 | 1,416,000 |
| **B.** | **Solar Power Supply** | | | | | |
| B.3 | Solar power For BS (50W) | 5,000 | 60 | 300,000 | 54,000 | 354,000 |
| B.3 | UPS (Without Battery) - 800VA | 12,500 | 60 | 750,000 | 135,000 | 885,000 |

| | | | | | | |
|---|---|---|---|---|---|---|
| B.3 | Battery For UPS (50W for 4H Backup) | 7,500 | 60 | 450,000 | 81,000 | 531,000 |
| B.3 | CCU (100W) | 5,000 | 60 | 300,000 | 54,000 | 354,000 |
| B.3 | Solar power For CPE (50W) | 5,000 | 240 | 1,200,000 | 216,000 | 1,416,000 |
| B.3 | UPS (Without Battery) - 500VA | 10,000 | 240 | 2,400,000 | 432,000 | 2,832,000 |
| B.3 | Battery For UPS (50W for 4H Backup) | 7,500 | 240 | 1,800,000 | 324,000 | 2,124,000 |
| B.3 | CCU (100W) | 5,000 | 240 | 1,200,000 | 216,000 | 1,416,000 |
| **B.** | **Miscellaneous** | | | | | |
| B.4 | Misc Wiring & other Materials | 9,500 | 300 | 2,850,000 | 513,000 | 3,363,000 |
| B.4 | Earth Pit | 5,000 | 300 | 1,500,000 | 270,000 | 1,770,000 |
| **B.** | **Installation and Commissioning** | | | | | |
| B.5 | For Base Station | 23000 | 60 | 1,380,000 | 248,400 | 1,628,400 |
| B.5 | For CPE | 10000 | 240 | 2,400,000 | 432,000 | 2,832,000 |
| **C.** | **Operations and Maintenance (OPEX)** | | | | | |
| C.1 | Operation & Maintenance cost per year (50% to be generated using revenue from wireless service) per village | 22,500 | 300 | 6,750,000 | 1,215,000 | 7,965,000 |
| **D.** | **Leased line connectivity for annum** | | | | | |
| D.1 | 100Mbps leased line for internet connectivity (Approximately) | 600,000 | 0 | 0 | 0 | 0 |
| | ** The exact height of the poles will be dependent on a detailed RF plan. | | | | | |
| | **Total Budget for ITI** | | | **34,080,0** | **6,134,4** | **40,214,4** |
| | TOTAL FOR PILOT PROJECT | | | 75,850, | 13,653, | 89,503,0 |
| | Project Management & Supervision Cost of ITI | 10% | 1 | 7,585, | 1,365, | 8,950,3 |
| | Total including Project Management & Supervision Cost of ITI | | | 83,435,000 | 15,018,300 | 98,453,300 |
| | Independent Agency Evaluation Cost | 1.5% | 1 | 1,251, | 225,274 | 1,476,8 |
| | **Grand Total of the Pilot Project** | | | **84,686,5** | **15,243,5** | **99,930,1** |
| Shipping and transportaion of equipments not included | | | | | | |

# 6. Scan of global approach to R&D in IoT and other emerging technology areas

# Scan of global approach to R&D in IoT and other emerging technology areas

## 1.1 Europe's IoT Policy

A set of supporting policy actions have been adopted by the European Commission to accelerate the take-up of IoT and to unleash its potential in Europe for the benefit of European citizens and businesses.

### 1.1.1 Alliance for Internet of Things Innovation (AIOTI) 2015:

The Alliance for Internet of Things Innovation (AIOTI) was launched in 2015 by the European Commission to support the creation of an innovative and industry driven European IoT ecosystem. The European Commission is working closely with AIOTI and all IoT stakeholders and actors towards the establishment of a competitive European IoT market and the creation of new business models. Currently, the AIOTI is the largest European IoT Association. AIOTI activities are carried out through Working Groups, which focus on well-defined areas of development. These include horizontal areas: R&D eco-systems, policy, standards and distributed ledger technologies, as well as vertical, cross-disciplinary activities focused on key IoT issues.

In August 2018, AIOTI has published recommendations for the future IoT research priorities under Horizon Europe and Digital Europe programmes 2021-2027. This work continued with priorities for the new political cycle in the EU (2019-2024) and Strategic Foresight Through Digital Leadership: IoT and Edge Computing Convergence.

The European Commission has also published a staff working document 'Advancing the Internet of Things in Europe' in 2016. This document is part of the 'Digitising European Industry' initiative and specifies the EU's IoT vision, based on 3 strands:

a thriving IoT ecosystem;
a human-centred IoT approach;
a single market for IoT.

For a better understanding of the ecosystem, the Cluster Study (2019) has investigated the landscape of physical and virtual clusters. These includes clusters of enterprises, research organisations and academia working on the innovation, development and market deployment of IoT technologies and applications.

A potential obstacle for the achievement of a single market for IoT has to do with issues linked to the capacity to handle a large diversity and very large volumes of connected devices, and the need to securely identify them and be able to discover them so that they can be plugged into IoT systems. In this context it is important to promote an interoperable IoT numbering space for a universal object identification that transcends geographical limits. It is also important to promote an open system for object identification and authentication. Some aspects of numbering are already addressed in the 2016 review of the EU's telecoms rules.

The 'European strategy for data' contributes to the creation of a European single market for IoT. This strategy proposes policy and legal solutions concerning the free flow of data across national borders in the EU, and liability issues in complex environments such as the IoT one. Liability is crucial to enhancing legal certainty around IoT products and services. To provide a first mapping of liability challenges that occur in the context of emerging digital technologies, including IoT, the European Commission published a staff working document on liability for emerging digital technologies.

### 1.1.2 IoT research & development and innovation: Government Initiatives

A wide range of R&D and application projects in Europe have been set up in different application fields. Communication between these projects is an essential requirement for a competitive industry and for a secure, safe and privacy preserving deployment of IoT in Europe.

### 1.1.3 Horizon 2020:

For the period 2014-2020 under Horizon 2020, the European research and innovation programme, the EU will have invested almost €500 million in Internet of Things-related research, innovation and deployment.

### 1.1.4 IoT European Platform Initiative (IoT-EPI) 2016:

In order to support IoT research and innovation (R&I), Europe promotes the idea of open and easy accessible IoT platforms. In 2016 the 'IoT European Platform Initiative (IoT-EPI)' was launched to build a vibrant and sustainable IoT-ecosystem in Europe, maximising the opportunities for platform development, interoperability and information sharing. Seven leading research and innovation projects: Inter-IoT, BIG IoT, AGILE, symbIoTe, TagItSmart!, VICINITY and bIoTope. make their technology accessible to 3rd parties. In addition, strong support & funding structure (open calls, workshops) fosters further collaboration. Learn more about IoT-EPI.

### 1.1.5 IoT European Large-Scale Pilots Programme:

The European Commission also supports the IoT European Large-Scale Pilots Programme includes the innovation consortia that are collaborating to foster the deployment of IoT solutions in Europe through integration of advanced IoT technologies across the value chain, demonstration of multiple IoT applications at scale and in a usage context, and as close as possible to operational conditions. For more information,

### 1.1.6 European Research Cluster on the Internet of Things (IERC):

The aim of European Research Cluster on the Internet of Things is to address the large potential for IoT-based capabilities in Europe and to coordinate the convergence of ongoing activities. IERC will facilitate the knowledge sharing at the global level and will encourage and exchange best practice and new business models that are emerging in different parts of the world. In this way, measures accompanying research and innovation efforts are considered to assess the impact of the Internet of Things at global and industrial level, as well as at the organisational level. For more information,

### 1.1.7 IoT European Security and Privacy Projects (IoT ESP):

The aim of this cluster is to share experiences on approaches and tools for risk assessment and threat analysis in IoT domain from cluster's project members perspective and based on that contribute to standards, offering a joint position of the group of IoT security related and practical oriented projects, co-founded by EU. For more information,

## 1.2 Artificial Intelligence (AI):

Artificial intelligence (AI) is a wide-ranging tool that enables people to rethink how we integrate information, analyze data, and use the resulting insights to improve decision making—and already it is transforming every walk of life.
Artificial intelligence (AI) holds great economic, social, medical, security, and environmental promise. AI systems can help people acquire new skills and training, democratize services, design and deliver faster production times and quicker iteration cycles, reduce energy usage, provide real-time environmental monitoring for pollution and air quality, enhance cybersecurity defenses, boost national output, reduce healthcare inefficiencies, create new kinds of enjoyable experiences and interactions for people, and improve real-time translation services to connect people around the world. For all of these reasons and many more researchers are thrilled with the potential uses of AI systems to help manage some of the world's hardest problems and improve countless lives.

In order to realize this potential, many countries and organizations around the world are approaching the benefits and risks of AI. This paper highlights a global landscape of national and international AI Policies/strategies.

### 1.2.1 Artificial Intelligence Policy[1]: European Union

1 https://ec.europa.eu/digital-single-market/en/artificial-intelligence

Europe has a robust AI industry and countries within the EU have continued to emphasize the importance of joining forces and showing a unified "European AI Alliance". The AI Alliance acts as a multi-stakeholder forum engaged in a broad and open discussion of all aspects of AI development and its impact on the economy and society.
In March 2018, the European Commission established a High-Level Expert Group to gather expert input and develop guidelines for AI ethics, which were built upon a statement by the European Group on Ethics in Science and New Technologies.
In the first year after its creation, the AI HLEG delivered on the following:

1. Ethics Guidelines on Artificial Intelligence: The Guidelines put forward a human-centric approach on AI and list 7 key requirements that AI systems should meet in order to be trustworthy. These requirements will go through a piloting process expected to conclude with the presentation of a revised document in early 2020.

2. Policy and Investment Recommendations: Building on its first deliverable, the group has put forward 33 recommendations that can guide Trustworthy AI towards sustainability, growth and competitiveness, as well as inclusion – while empowering, benefiting and protecting human beings. The recommendations will help the Commission and Member States to update their joint coordinated plan on AI at the end of 2019. This is expected to play a key role in building the future of Artificial Intelligence in Europe.

By singing up to AI Alliance, Members can interact with the experts of The High Level Expert Group on AI (HLEG-AI) and can offer input and feedback to HLEG-AI.

One component of the "European AI Alliance" is the Digital Single Market strategy, which was adopted in May 2015 to enhance digital opportunities for people and businesses throughout Europe. On June 6, 2018, the European Commission proposed an updated Digital Europe program with the investment of €9.2 billion to align the next long-term EU budget 2021-2027 with increasing digital challenges. €2.5 billion of this is planned to help spread AI across the European economy and society and to build on the European approach on AI[2] presented on April 25, 2018.

Given the strategic importance of the AI and the support shown by the European countries signing the declaration of cooperation during the Digital Day 2018. On 10 April 2018, 25 European countries signed a Declaration of cooperation on Artificial Intelligence. It builds further on the achievements and investments of the European research and business community in AI.

On 19 February 2020, the European Commission published a White Paper aiming to foster a European ecosystem of excellence and trust in AI and a Report on the safety and liability aspects of AI.

In May 2018, The General Data Protection Regulation (GDPR) – a wide-ranging regulation intended to strengthen and unify data protection for all individuals within the EU – went into effect. GDPR was approved by the EU Parliament on April 14, 2016 and replaces the Data Protection Directive 95/46/EC. It extends the scope of the EU data protection law to all foreign companies processing data of EU residents. GDPR implicates AI for several reasons including that it requires a certain amount of explainability, which can be challenging with "black box" AI systems.

### 1.2.2 Artificial Intelligence Policy[3]: United States

2019 was a monumental year for artificial intelligence (AI) policy in the United States. The federal government took several important steps that prioritized AI development and deployment and positioned the United States to strengthen its global AI leadership, beginning with issue of an Executive Order launching the American AI Initiative on February 11, 2019. The Executive Order explained that the Federal Government plays an important role not only in facilitating AI R&D, but also in promoting trust, training people for a changing workforce, and protecting national interests, security, and values. And while the Executive Order emphasizes American leadership in AI, it is stressed that this requires enhancing collaboration with foreign partners and allies.

The American AI Initiative is guided by five principles, which include (in summarized form), the following: 1. Driving technological breakthroughs, 2. Driving the development of appropriate technical standards, 3. Training workers with the skills to develop and apply AI technologies, 4. Protecting American values including civil liberties and privacy and fostering

2 https://digital-strategy.ec.europa.eu/en/policies/european-approach-artificial-intelligence

3 https://futureoflife.org/ai-policy-united-states/

public trust and confidence in AI technologies, 5. Protecting US technological advantage in AI, while promoting an international environment that supports innovation.

In May 2019, the United States has also joined dozens of other countries in adopting the OECD AI Recommendation, the first intergovernmental standard for AI, which includes five complementary values-based principles and five recommendations to governments. The US also joined the G20 countries in supporting the G20 AI Principles, which are drawn from the OECD Recommendation. In September 2019, the US Chamber of Commerce released Principles on Artificial Intelligence, which also endorse the OECD Recommendation and include a call for US businesses to abide by international standards.

*On March 19, 2019, the US federal government has also launched AI.gov to make it easier to access all of the governmental AI initiatives currently underway. The site is the best single resource from which to gain a better understanding of US AI*
*strategy. As of February 2020, there is also extensive information, data, and graphics about AI policy in the US available at the OECD AI Policy Observatory.*

### 1.2.3 Artificial Intelligence Policy: Singapore

In November 2019, Singapore launched a National AI Strategy[4]. The strategy identifies five national AI projects including transport and logistics, smart cities and estates, healthcare, education, and safety and security. These projects are intended to address key challenges that will help ensure Singaporeans experience successful and sustainable AI innovation and adoption. The national strategy calls for support from the private and public sectors, as well as international partners. One part of the strategy is a Model AI Governance Framework.

In May 2017, Singapore has also established a national program called AI Singapore to harness AI throughout the country. The program was set up by the government to invest up to S$150m in AI over the next 5 years. The objectives of AI singapore are to use AI to address major challenges that affect society and industry, to invest in deep capabilities to catch the next wave of scientific innovation, and to broaden adoption and use of AI and machine learning within industry. It focuses on three key industry sectors: finance, city management solutions, and healthcare. Two more recent programs launched by AI Singapore include AI for Everyone (AI4E) and AI for Industry (AI4I). These programs help showcase the utility of AI advances to a wider range of Singaporeans and to industry professionals.

## 1.3 Blockchain:

Blockchain is a system of recording information in a way that makes it difficult or impossible to change, hack, or cheat the system.
A blockchain is essentially a digital ledger of transactions that is duplicated and distributed across the entire network of computer systems on the blockchain. Each block in the chain contains a number of transactions, and every time a new transaction occurs on the blockchain, a record of that transaction is added to every participant's ledger. The decentralised database managed by multiple participants is known as Distributed Ledger Technology (DLT).
Below is the list of few policy initiatives which have been announced by EU and Singapore.

### 1.3.1 EU Blockchain Strategy

The European Commission's strategy is designed to meet these goals. It wants to support a 'gold standard' for block chain technology in Europe that embraces European values and ideals in its legal and regulatory framework. The most significant elements of the EC's blockchain strategy include:

**Developing joint visions and initiatives** through a European Blockchain Partnership harnessing national blockchain efforts into a pan-European approach.

**Building a pan-European government services blockchain**: the EBP commits the European public sector to play a trailblazing role in blockchain by building its own blockchain backbone infrastructure for corporation across borders- the European Blockchain Services Infrastructure (EBSI).

4 https://www.smartnation.gov.sg/why-Smart-Nation/NationalAIStrategy

**Promote legal certainty**: The European Commission is proposing a comprehensive pro-innovation legal framework in the area of digital assets and smart contracts.

**Increasing funding for blockchain innovation**: the EU provides funding of blockchain research and innovation both in the form of grants and by supporting investment in startups.

**Supporting interoperability and standards**: the EC believes strongly in the importance of standards in promoting blockchain technology and looks to engage with all relevant bodies globally.

**Supporting blockchain skills development**: the EC supports initiatives focused on blockchain education in order to ensure the high level skills that are needed are available.

**Interacting with the community**: the EC interacts with the private sectors, academia and the blockchain community primarily through bodies like the European Union Blockchain Observatory and Forum, the **International Association of Trusted Blockchain Applications (INATBA).**

### 1.3.2 EU Blockchain Observatory and Forum

In February 2018, the European Commission has launched the EU Blockchain Observatory and Forum, to accelerate blockchain innovation and the development of the blockchain ecosystem within the EU and so help cement Europe's position as a global leader in this transformative new technology.
The EU Observatory will:

- Map key existing initiatives in Europe and beyond;
- Monitor developments, analyse trends and address emerging issues;
- Become a knowledge hub on blockchain;
- Promote European actors and reinforce European engagement with multiple stakeholders;
- Represent a major communication opportunity for Europe to set out its vision and ambition on the international scene;
- Inspire common actions based on specific use-cases of European interest.

It has established following two Working Groups (WGs) to identify and research existing blockchain initiatives throughout the EU and beyond:

- The **Blockchain Policy and Framework Conditions Working Group** will look at cross-technology and cross-industry issues to define the policy, legal and regulatory conditions needed to promote the regulatory and legal predictability necessary for larger-scale deployment of blockchain applications.
- The **Use Cases and Transition Scenarios Working Group** will focus on the most promising transformative blockchain use cases with an emphasis on public sector applications such as identity and government services, health care, energy and environmental reporting.

### 1.3.3 European Blockchain Partnership 2018

In April 2018, 21 Member States and Norway agreed to sign a Declaration creating the **European Blockchain Partnership (EBP)** and cooperate in the establishment of a **European Blockchain Services Infrastructure (EBSI)** that will support the delivery of cross-border digital public services, with the highest standards of security and privacy. Since then, eight more countries have joined the Partnership, bringing the total number of signatories to 30.

In December 2019, the European Commission also started an open market consultation in preparation of the **European Blockchain Pre-Commercial Procurement** that is looking for novel, improved blockchain solutions for the future evolution of the European Blockchain Service Infrastructure. Interested market parties are invited to participate in the open market consultation activities.

### 1.3.4 Singapore Blockchain Innovation Programme 2020

A S$12 million Singapore Blockchain Innovation Programme (SBIP)[5] was launched in December 2020 with a mandate to further strengthen Singapore's blockchain ecosystem. SBIP facilitates the adoption of blockchain systems for real-world applications through **3 key strategies**:

- Engaging local companies
- Growing Singapore's blockchain community
- Researching on next-generation blockchain

The Singapore Blockchain Innovation Programme will engage close to 75 companies including multinational corporations, large enterprises and info-communications technology companies, to conceptualise 17 blockchain-related projects within the next three years in sectors such as trade and logistics.

**Government initiatives for a resurgent India**

### 1.4 5G/ IoT/ Digital Initiatives and Roadmap of the Indian Government

The Indian Government has taken bold measures to develop the local ecosystem, some of which are shown in the figure below:


The Indian Express wrote about the NDCP 2018 describing it as:

The National Digital Communications Policy-2018 (NDCP) has been formulated to facilitate India's effective participation in the global digital economy. The policy aims to ensure digital sovereignty. The key features of the policy are as below:

- Provide universal broadband connectivity at 50 Mbps to every citizen.
- Provide 1 Gbps connectivity to all Gram Panchayats by 2020 and 10 Gbps by 2022.
- Ensure connectivity to all uncovered areas.
- Attract investments of USD 100 billion in the Digital Communications Sector.
- Train one million manpower for building New Age Skill.

5 https://sbip.sg/

- Expand IoT ecosystem to 5 billion connected devices.
- Establish a comprehensive data protection regime for digital communications that safeguards the privacy, autonomy and choice of individuals.
- Facilitate India's effective participation in the global digital economy.
- Enforce accountability through appropriate institutional mechanisms to assure citizens of safe and secure digital communications infrastructure and services.

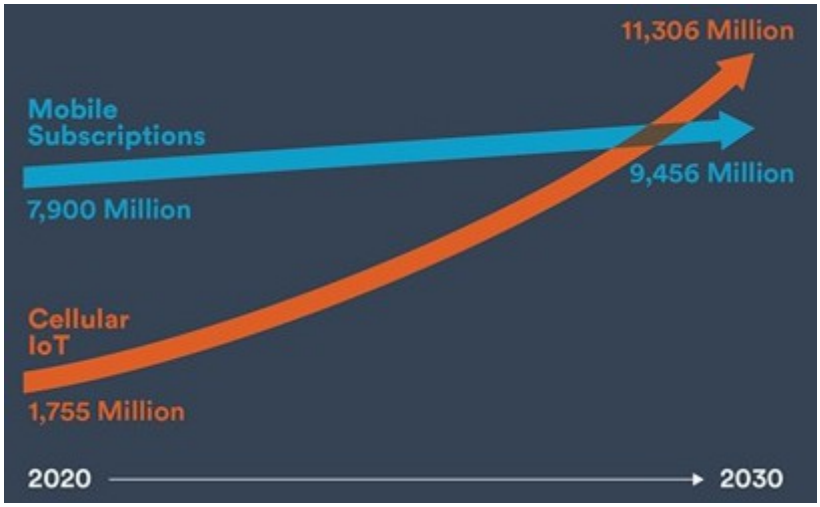
One of its objectives is to ensure connectivity to all uncovered areas and attract investments of $100 billion in the Digital Communications Sector. Besides this, one million manpower will be trained for building New Age Skill. It also aims at expanding IoT ecosystem to 5 billion connected devices. The IoT is the network of physical devices, vehicles, home appliances, and other items embedded with electronics, software, sensors, actuators, and connectivity. This enables these things to connect, collect and exchange data, creating opportunities for more direct integration of the physical world into computer-based systems. IoT results in efficiency improvements, economic benefits, and reduced human exertions.
"

## 1.5 DoT's IoT/ M2M Roadmap

The Department of Telecommunications has published an IoT/ M2M Roadmap in 2015, identifying several key facets of the agenda:
1. To facilitate M2M communication standards including encryption, quality, security and privacy standards from Indian Perspective and to recognize such standards for India.
2. To release national M2M Numbering Plan
3. To address M2M Quality of Service aspects.
4. To address M2M specific Roaming requirements.
5. To formulate M2M Service Provider (MSP) registration process.
6. To issue guidelines for M2M specific KYC, SIM Transfer, International roaming etc.
7. Formation of APEX body involving all concerned stake holders.
8. To address M2M specific spectrum requirements.
9. To define frequency bands for PLC communication for various Industry verticals
10. Finalization of M2M Product Certification process and responsibility centers.
11. Facilitating M2M Pilot projects.
12. Measures for M2M Capacity building.
13. To establish Center of Innovation for M2M.
14. To assist M2M entrepreneurs to develop and commercialize Indian products by making available requisite funding (pre-venture and venture capital), management and mentoring support.
15. Inclusion of M2M devices in PMA Policy.
16. To take up matters with relevant ministries to boost M2M products and services.
17. Define procedures for energy rating of M2M devices and implementation of same.
18. To evolve suitable guidelines of EMF radiation of M2M devices based on research and studies by relevant bodies.
Indian Research and Development are critical to enabling many of the agenda identified above.

## 1.6 Indian IoT/ M2M Market place

The IoT market is set to exceed the human connections by the turn of this decade, an estimate from research agency is shown below:




According to Research and Markets “Indian IoT market is expected to witness a significant growth with the CAGR of approximately 21.9% during the forecast period of 2019-25. Indian IoT market is segmented on the basis of infrastructure, vertical and application. Based on the infrastructure, the market is segmented into platform, mobile networks and access technologies, cloud solutions/storage and processing, analytics and security. Based on the vertical, the market is segmented into automotive, aerospace, transportation, energy, healthcare, e-governance, BFSI, hospitality, entertainment, retail, home, industrial, manufacturing, railways, marine and defense. Further, based on the infrastructure, the market is segmented into consumer (smart home, smart wearable) and Industrial (smart cities, smart grid, IoT, IIoT, IoT connected cars, IoT connected healthcare, Drones, etc.).

## 1.7 Role of the Government

Government policy, procurement and spending is likely to play a huge role in how the IoT ecosystem in India readies and shapes up. The government policy in the following barriers can liberate the challenges and enable a fast growth of the local IoT ecosystem

Registration and recognition of M2M Service Providers for the orderly proliferation of secure and quality services

a. IoT is a new developing ecosystem, standards based quality, security and safety of services is paramount for the rapid adoption

b. DoT has taken the pioneering step of adopting the oneM2M standards as national standards

c. DoT had released the draft policy for registration of IoT/ M2M Service Providers in July 2016, which is still pending

d. The absence of proper registration and provisioning of the rights to rollout services is a significant barrier to investment and standards based services development. The policy for registration of IoT/ M2M Service Providers should be notified immediately

Incentive on R&D

e. The government must provide incentive to Registered M2M Service Providers to invest in Key Areas of national interest

- e.i. National Trust Centre Systems
- e.ii. Cellular-V2X systems
- e.iii. Financial Systems
- e.iv. IoT solutions for Smart Grid and AMI
- e.v. Mobile data Security and Privacy
- e.vi. SIM Card Operating Systems
- e.vii. Manufacturing of IoT devices such as telematics, metering, road safety
- e.viii. Rural and Remote connectivity
- e.ix. Financial Services

f. All the Key Areas should be notified and covered under Preferred Market Access (PMA)

g. Research in all the Key Area services must be allowed to be covered under CSR spending

Preferred Market Access

h. Preferred market access must be provided to all Key Areas

i. Only such products which have more than 70% Indian R&D and more than 60% local value should qualify for PMA Products

Private Networks and IoT Spectrum

j. The Government must allow the registered IoT / M2M SP to offer private networks in the IoT use cases

k. Certain critical sectors such as Mining, Remote Area Management, Metering, Cellular V2X must be allowed for IoT/ M2M SP

l. Spectrum must be made available at very reasonable rates for micro local area IoT network deployment

Local Standards and Certification

m. TEC Standards must be developed including in areas where TEC endorses global standards or where TSDSI transposes global standards

n. TEC should invest massively in engaging the local ecosystem for development of Test Processes and Test tools

o. All the Certification required for Indian IoT services must be locally handled by TEC accredited labs in India, including SAS Certification

Incentivizing Indian R&D

The Working Group for the 12th Plan in Telecom sector had proposed to create following funds for promoting R&D and Manufacturing of Telecom Equipment during the 12th Five Year Plan period:

| | |
|---|---|
| **Telecom Manufacturing Promotion Fund (TMPF)** | **Rs 10,000 crore** |
| **Telecom Entrepreneurship Promotion Fund (TEPF)** | **Rs 2,500 crore** |
| **Telecom Research Development Fund (TRDF)** | **Rs 5,000 crore** |
| **Total Fund requirement** | **Rs 17,500 crore** |

A MULTI-PRONGED APPROACH was proposed for CRITICAL CHALLENGES FACED BY DOMESTIC TELECOM INDUSTRY addressing INNOVATION, INCUBATION AND GLOBAL SCALE OPERATIONS

INNOVATE

- R&D and Product development
- Creation of IPR and patents
- Soft Loans & Grants (exceptional cases)
- Common testing and standardization

INCUBATE

- Startup/Risk Financing
- Incubation Centers, Accelerators and Innovation labs
- Strengthen telecom entrepreneurship leadership and engineering capability

GLOBAL SCALE

- Low interest, long-term funding for Indian Products
- Subsidies/incentives to overcome disabilities
- Promote success in India and also globally

## 1.8 TELECOM PRODUCT FUNDs: HIGH-LEVEL OBJECTIVES

The objective of the Telecom Product Fund is to establish a corpus to promote indigenous R & D, IPR creation, entrepreneurship, manufacturing, commercialization and deployment of state-of-the-art telecom products and services during the 12th Five Year Plan period.

In order to realize this vision, the Telecom Product Fund will be divided into three distinct schemes, namely, the

i) Telecom R&D Fund (TRDF),
ii) Telecom Entrepreneurship Development Fund (TEDF) and
iii) Telecom Manufacturing Promotion Fund (TMPF).

The implementation of these three schemes will be harmonized to incentivize indigenous development of telecom products and meet the end-to-end funding requirements of telecom R&D starting from the ideation stage to incubation and commercial growth stages.

The key objectives of the "Telecom R&D Fund" are the following:

a.i. To fund commercially viable product development with current/future market potential by Indian telecom companies and R&D labs including early-stage prototype development in high-potential areas such as VLSI chip design, embedded software for telecom gear and secure elements, equipment's, terminals (including mobile and tablets) and customer premise equipment,

a.ii. To fund projects with a clear focus towards development of products/services, including those which may have potential for generation of patents/IPRs, possible inclusion in international standards. This will also include funding acquisition of patents and IPRs at a country level.

a.iii. To create common testing and Innovation Lab facilities in public/public-private partnership (PPP) mode.

The key objectives of the "Telecom Entrepreneurship Development Fund" are the following:

a.iv. Establish a conducive and world-class ecosystem for transforming innovative ideas to products and services for telecom start-ups

a.v. Build new and leverage the existing incubation infrastructure (physical and technical) in India to provide world-class support to innovators and entrepreneurs to build global companies that are based in India.

a.vi. Leverage the human resources and expertise existing in research/academic institutes in India to create a pipeline of entrepreneurial leadership and telecom engineering talent

a.vii. Accelerate Research and Spin-off technologies being developed by innovators into viable enterprises

a.viii. Attract the best brains in the country to collaboratively work towards solving problems of mass applications and creating indigenous solutions for areas of strategic importance such as space, energy, internal security and defence.

The key objectives of the "Telecom Manufacturing Promotion Fund" are the following:

a.ix. Stimulate and promote the complete value chain of domestic telecom equipment covering R&D, design, IPR creation, testing and manufacturing of telecom equipment in the country. This shall also cover components and software that is required as a part of telecom equipment.

a.x. Provides incentives and financing support to create a large and healthy ecosystem of globally competitive Indian telecom equipment companies, by removing fiscal and other impediments that are coming in the way of commercial success of Indian telecom products in India as well as internationally.

a.xi. Achieve increased self-reliance in telecom products (including handsets/tablets and customer access equipment), reduce imports and address national security concerns. Achieve NTP-2012 target of meeting 60% of Indian telecom sector demand with domestic value addition of 45% by 2017, and 80% of the Indian telecom sector demand with domestic value addition of 65% by 2020.

a.xii. Provide a thrust for exporting telecom products from India and make India a global hub for telecom equipment.

## 4. Forms of Funding

Telecom Product Funds may be disbursed in the following modes:

Soft Loans: These will be soft-secured loans at concessional interest rates that will be given to Indian Telecom Companies for developing Indian Products. The collaterals will be in the form of physical assets and IPR generated, which can be taken over by the government in case of default.

Interest Subsidies: In the telecom sector, large sums of working capital will be required, at competitive rates, by Indian Telecom Companies for their internal use and for providing long-term financing to customers (telecom operators). For such large requirements, the fund size will not be adequate and therefore these funds may be used to provide interest subsidy, while the actual lending will come from commercial banks.

Equity: In the case of SMEs or telecom startups supported by TEDF, funds will be treated as an investment in the venture. Other variants of equity instruments such as convertible debentures may also be considered. All the investments will be as per guidelines issued by the Securities & Exchange Board of India (SEBI) from time-to-time. The typical investment horizon would be 5-8 years although lower periods would also be considered.

Soft Loans/ Grants (in exceptional cases): R&D institutes and labs, telecom incubators, societies and section 25 companies with telecom research and development focus could be provided Soft Loans/ Grants (in exceptional cases) for purchase of tools and equipment once the project proposal is approved.

Post-performance Reimbursement: Indian Telecom Companies will be eligible for full or partial reimbursement of costs under various expense categories specified in the TRDF and TMPF funds.

Exclusivity of loans: The organisations seeking loans under any of these schemes should not be getting benefits from any other scheme of the government for the same purpose.

## 1.9 **Target Beneficiaries**

The following attributes will make the companies beneficiaries of the Telecom Product Fund incorporated in India with More than 50% equity owned by Indian Citizens or Indian entities the board constituted by majority of Indian Residents CEO/CFO/CTO being resident Indian citizens and global headquarters in India

Together with any one registration described below: IoT/ M2M Service Providers registered with DoT Start-Up registration up to three years before date of application of Funds DSIR approved R&D house Start-up registered with incubators of IITs/ BITS, Pilani/ IISC/ RECs

Small and Medium Enterprises and other new startup ventures in the telecom sector with a focus on R&D and in the development of “Indian Products” will have a preference.

## 1.10 **Product Criteria**

The Research must have an exclusive focus on telecom and digital products in the Key Areas listed below or as approved by DoT, DST or MEITY.
The design and IPR (except for patents that have been licensed and off-the-shelf components) should be exclusively owned by the Indian Telecom Company and revenues of global sales and commercial benefits of the Indian Product must accrue to Indian Telecom Company.

The product should meet the minimum Domestic Value Addition norms specified by DoT for that specific product
The design of the product, including hardware details and software source code, should be resident in India and be available for inspection by any agency designated by DSIR/ DoT/TPFGC council.

The product should be governed by the export control laws of India

1.11 Developing Indian **R&D in** Key Areas

- IoT/ M2M Domain Applications and Devices
- 5G Domain Applications
- Telecom Products and Infrastructure
- Industrial IoT and Industry 4.0
- Roots-of-trust, Certificate and Cybersecurity Infrastructure
- Test and Certification Infra
- Quantum Technology
- AI Applications
- Blockchain Applications

Funding Model

The funding model is substantially as per the **12th Five Year Plan period** and described below.
**A Telecom Product Fund corpus of Rs 17,500 crores will be created as below:**
Telecom R&D Fund of Rs 5000 crores
Telecom Entrepreneurship Development Fund of Rs 2,500 crores
Telecom Manufacturing Promotion Fund of Rs 10,000 crores

**The TRDF fund of Rs 5000 Cr shall be allocated as follows:**
The broad objectives of the fund (disbursed generally as soft loans or grants in exceptional cases), is proposed as follows:
75% for product development that includes early stage prototyping and commercialization
20% for generation of product IPRs/patents/standards
5% for common facilities
It is estimated that around 57% of the funds will be disbursed as loans that will return to the corpus and 43% of the funds will be distributed generally as soft loans with grants in exceptional cases through post-performance incentives for creation of software or capital assets created as a result of the project activities supported by the funds.
Income generated will be ploughed back into the fund every year

**The TEDF fund of Rs 2500 Cr shall be allocated as follows:**
Proposed allocation of funds (disbursed as equity/incentives/ loans):
25% as Angel/Seed Funds to Incubators
45% as Early Stage Venture Fund
30% as Capacity Building Fund
It is estimated that around 75% of the funds will be used as equity investments, 15% will be disbursed as post-performance incentives, and 10% will be used for loans that will return to the corpus
Income generated will be ploughed back into the fund every year

**The TMPF fund of Rs 10,000 Cr shall be allocated as follows:**
90% of the funds will be disbursed as post-performance incentives and interest subvention subsidies, while the remaining 10% will be made available as soft loans that will return to the corpus Proposed allocation of funds will be under the following schemes:
8% as Initial Deployment Incentive for Indian Products
12% as Incentives for Export and Marketing Promotions
10% as incentives to Indian Operators to Buy Indian Products
10% as Soft Loans to Indian Telecom Companies
30% as Interest Subsidies for Working Capital Loans
30% as Interest Subsidies on Vendor Financing

Income generated will be ploughed back into the fund every year.

**KEY INITIATIVES UNDER TRDF**

TRDF fund will catalyze indigenous telecom product development through a thrust on IPR, R&D and Standardization activities. The key initiatives for which funds will be allocated are:

- **FUNDS FOR PRODUCT DEVELOPMENT (75% AMOUNTING TO RS 3750 CRORES)**

The fund will support early stage prototyping and commercialization of products with majority Indian IPR and maximum value addition in India

Soft Loans/ Grants (in exceptional cases) will be given to R&D Institutes/Sec 25 companies and societies/Indian Telecom Companies limited to the purchase of tools and development equipment
Soft Secured Loans at 3% interest to Indian Telecom Companies for up to 50% of the project costs; grants can be given in exceptional cases (50% costs to be borne by company)
The fund will also support Indian Telecom Companies working in the area of strategic or national importance and developing Indian products that have long term commercial viability. 20% of the Product Development corpus will be dedicated for this purpose. Funding may be provided up to Rs 25 crores per company in the form of equity or soft loans.

- **FUNDS FOR PATENTS/IPR/STANDARDIZATION ACTIVITIES (20% AMOUNTING TO RS 1000 CRORES)**

The fund will support creation of product patents and country-level acquisition of patent pools (that can be licensed to Indian Telecom Companies at 1% purchase value)
Soft loans/ Grants (in exceptional cases) will be given to Universities/R&D Labs/Sec 25 companies/societies for approved projects; Soft secured loans can be provided at 3% to Indian Telecom Companies for IPR creation
Indian Telecom Companies can apply for reimbursement of actual patent filing/maintenance fees

- **FUNDS FOR COMMON TESTING AND LAB FACILITIES (5% AMOUNTING RS 250 CRORES)**

The fund will be available for setting up common testing labs at national level in public/ public-private partnership mode and in incubators as Shared Infrastructure at regional level in public-private partnership model

Soft Loans/ Grants in exception cases will be available only for purchase of equipment and tools required for the labs and not for civil infrastructure, and other operations cost. Operational cost of running and maintaining the facility will be borne by the industry/incubator through suitable fees levied for the services.

**KEY INITIATIVES UNDER TEDF**

The vision of the TEDF fund is to build 1000 innovative and successful startup enterprises focused on providing telecom solutions for India within the next 5 years. The key initiatives to realize this vision for which funds will be allocated are:

**CAPACITY & ECOSYSTEM BUILDING FUND (30% AMOUNTING TO RS 750 CRORES)**

The fund will support creation of a world-class entrepreneurial development ecosystem at telecom startup incubation centers with an aim to create and support new generation telecom entrepreneurs and support from idea to IPO Stage of the startup. Each incubator is expected to support 100 to 1000 startups over a period of five years.

The fund will support upto 10 incubators for capacity building with each incubator receiving 10Cr to 100Cr as post-performance incentives or in the form of equity investments

The fund can be utilized by the incubators for

- Creating Hard Infrastructure such as Innovation Labs, Purchase of Telecom Equipment for R&D, High End Video Conference/ Telepresence Rooms
- Provide Soft Infrastructure Services to the startups such as Computers, Laptops, High End Servers, Work Stations etc
- Provide support Infrastructure Services such as Accounting, Audit and Financial Services Cell, IPR Cell, Legal Services Cell, Business Operations Cell and Venture Capital Cell.
- Creation of Knowledge Hubs to develop and conduct entrepreneurship training programmes, business management, and telecom technical/engineering training courses at the incubators
- Incubation Centers, which have reached a sizeable operational scale, can also utilize the funds for Setting up of Global Telecom Accelerator Programmes to guide the mature startups move to market commercialization globally

**ANGEL/SEED FUNDS TO INCUBATORS (25% AMOUNTING TO RS 625 CRORES)**

The fund will be employed to support up to 10 incubators, with each incubator receiving in the range of Rs 10 crores to Rs 100 crores.

The incubator, recognized by Department of Science and Technology or Department of Electronics & Information Technology, can be in a university or in private sector. It should have prior experience in incubating telecom startups and should have a line-up of telecom start-ups before applying for funding support.

Each incubator can make an investment ranging from Rs 2.5 lacs to 2.5 crores per startup in the form of equity or soft loan with grants being considered in exceptional cases.

**EARLY STAGE VENTURE FUND (45% AMOUNTING TO RS 1125 CRORES)**

The fund aims to support telecom startups who are in the pre-commercialization, pilot trial and go-to-market stages of their products

The fund will create up to 10 daughter funds in a PPP mode with reputed VC/PE firms, with Rs 50 to 200 crores allocated per fund

The VC partner for a daughter fund will be expected to raise 1x – 2.5x funds from private/other sources to qualify.

**KEY INITIATIVES UNDER TMPF**

TMPF fund will promote successful commercialization and scaling-up of Indian Products at global levels, by removing fiscal handicaps, providing incentives and assuring long-term funding. The key initiatives for which funds will be allocated are:

**INITIAL DEPLOYMENT INCENTIVE (8% AMOUNTING TO RS 800 CRORES)**

An “Initial Deployment Incentive” of 30% of the sale value will be provided to Indian Product companies for initial sales of each Indian Product family, subject to a maximum initial threshold sales level.

The threshold sales level will be different based on the specific product family and will be decided by TMPF committee. Any Indian Telecom Company can claim such a benefit only once, for each major technology/product family.

This incentive shall be in the form of reimbursement, which shall be payable after successful sales of the product, based on the certified information provided by the company.

**INCENTIVES FOR EXPORT/MARKETING PROMOTION (12% AMOUNTING TO RS 1200 CRORES)**

TMPF will reimburse 50% of the total cost (including travel on economy class, reasonable stay, exhibition fees and other marketing expenses) to Indian Telecom Companies participating in relevant international trade shows (for their products), subject to a maximum of Rs 25 Lacs per company per event.

TMPF will fund up to 12 industry/TEPC events per year, for targeted trade promotion events in specific countries, where Indian Telecom Companies will showcase their products and technologies to CXO and key decision makers of operators in that country. Cost of such events will be borne upto 75% by TMPF. The total reimbursements shall be subject to a maximum of Rs 75 Lacs per event.

Sales/marketing costs incurred by companies for international sales/marketing efforts (including cost of manpower/ office) will be reimbursed at 50% of actual, subject to a maximum of Rs 5 Cr per company per year. Any company interested in availing this incentive, should submit their sales/marketing proposal to TMPF committee every year, so that the same can be evaluated and approved a-priori.

Marketing/branding expenses incurred by Indian Telecom Companies for webinars/advertising in online/print media/social media as well as costs incurred by Indian Telecom Companies for international market research, market reports/white papers will be reimbursed at 50% of the costs, subject to a maximum of Rs 50 Lacs per company per year.

**INCENTIVES TO INDIAN OPERATORS FOR BUYING INDIAN PRODUCTS (10% AMOUNTING TO RS 1000 CRORES)**

The fund will incentivize Indian Telecom Service providers to buy Indian Products by rewarding those operators who spend a significant portion of their annual capex on Indian Products and help grow the domestic telecom ecosystem.

Operators shall be eligible to get an incentive from TMPF, equal to 5% of the value of the Indian Products that they buy during the financial year, subject to them purchasing at least 50%of their total annual procurement in that product category from domestic product suppliers. If they don’t fulfill the value addition for that product category as required, they will not be eligible to get this incentive.

The incentive shall be reimbursed after the end of each fiscal year based on certified information provided by the operator on the amount of Indian Products that they have actually purchased.

**SOFT LOANS TO INDIAN PRODUCT COMPANIES (10% AMOUNTING TO RS 1000 CRORES)**

Soft loans at 3% interest rate will be given to Indian Product companies for specific product development/commercialization activities including purchase/rental of test/capital equipment, prototypes, testing/compliance/certification fees, NRE expenses, customer trials/demos and associated manpower costs.

Upto 50% of the actual Project Cost shall be eligible for soft loans. Such loan shall be disbursed in parts after matching spending by the company and subject to meeting of pre-defined project milestones.

The loan shall be returnable in six equal half -yearly installments in the third, fourth and fifth years after disbursement, following a two-year moratorium to accommodate product commercialization time. Physical assets purchased from this loan shall be usable as collaterals and there shall be no requirement for any additional collateral elements.

**INTEREST SUBSIDY FOR WORKING CAPITAL (30% AMOUNTING TO RS 3000 CRORES)**

High working capital costs in India contribute to a large portion of the fiscal handicap that Indian Telecom Product companies face against their global competitors. TMPF will provide interest subsidy to Indian Telecom Companies so as to ensure that their effective working capital rates are competitive when compared to what other global telecom companies get in their countries.

While the actual working capital loan will be disbursed by commercial banks, TMPF will provide the working capital subsidy, in the form of reimbursement equaling the PLR charged by the bank for such loan.

**INTEREST SUBSIDY FOR VENDOR FINANCING (30% AMOUNTING TO RS 3000 CRORES)**

The fund will support Indian Product Companies to offer long-term financing, at competitive interest rates to telecom operators, in-line with what is offered by international competitors with support from their country's banks.

While the actual loan will be disbursed by commercial/EXIM banks, TMPF will provide the interest subsidy, in the form of reimbursement equaling the PLR charged by the bank for such loan.

To the extent possible, TMPF will work with banks in India to enable such long-term credit to Indian Product companies to extend credit facilities to their customers. Such financing will be for a period of up to 5 years, with initial moratorium on payments for a period of up to 3 years.

# 7. White Paper on TSDSI's 5G Radio Interface Technology

# White Paper on TSDSI's 5G Radio Interface Technology

5Gi is one of the Radio Interface Technologies (RITs) proposed by TSDSI (Telecom Standards Development Society India) and approved by ITU as a candidate technology for 5G.
ITU approved 3 Radio Interface Technologies (RITs) in Nov 2020 as the candidate RITs that meet all the requirements for 5G as outlined in IMT-2020 requirements. Following are the 3 approved RITs:

1. 3GPP RIT - defines the specification for 5G NR (New Radio) operating at FR1 and FR2 spectrum in 3GPP release 15 and beyond. This specification provides all details related to NR. This set of specification is applicable to gNB.

2. 3GPP SRIT - defines a set of specifications for LTE (E-UTRA, Evolved Universal Terrestrial Radio Access) and NR (new radio) operating at FR1 (LTE + NR) and FR2 (NR) spectrum in 3GPP release 15 and beyond. This set of specifications are applicable to both ng-eNB and gNB.

3. 5Gi – defines the specification for 5G NR to support a use case to extend the inter-site distance of the base stations that will promote rural broadband. This specification applies to gNB operating at FR1 and FR2 spectrum. While ITU has approved this specification, the configuration required to activate this interface is made optional in 3GPP. However the feature can be activated with minimal changes in the User Equipment (UE) and gNB. The feature can be activated at gNB with a software upgrade.

All the 3 RITs meet all the performance requirements in the 5 deployment scenarios outlined by ITU, i.e.

a. Indoor Hotspot – enhanced Mobile Broadband (eMBB),
b. Dense Urban – eMBB,
c. Rural – eMBB,
d. Urban Macro – Ultra Reliable Low Latency Communication (URLLC) and
e. Urban Macro – massive Machine Type Communication (mMTC)

The key focus of 5Gi is to support the Rural Communication needs in a cost-effective manner. The 5Gi considers a low mobility use case for rural communication to extend the inter-site distance to reduce the deployment cost substantially. 5Gi introduces a new waveform to boost power in the Uplink channel by 3dB. Pi by 2 BPSK waveform can achieve a coverage distance of 12 Km (under Line-of-Sight condition) with an average UE power of 23 dBm (max power of 26 dBm) and offers a 100kbps throughput at the cell edge. This throughput is good enough for making a video call from the cell boundary. Please note that the power boost can be applied to higher order modulation schemes to extend the range, if we don't violate the average power level of 23dBm for the specified device category. When 5Gi configuration is used, the UE and the gNB need to support an additional modulation scheme called Pi by 2 BPSK that enables extending the range of the base station or the inter-site distance of the base stations.

**Key driver for 5Gi waveform**

Primary intent behind this standard is to bridge the rural-urban digital divide in 5G deployment by supporting enhanced coverage. From Indian context this enables connectivity in villages through towers located at gram panchayats in a cost-effective manner. Standard has received support from several countries as it can addresses the regional needs from a 5G standpoint.
5Gi if implemented has a great potential of reducing the CAPEX and OPEX for rural broadband network solving the last mile connectivity issue, thus realizing our Honorable PM's vision for Digital India.
After making the head start with contribution to standard, onus is on us to take this innovation forward to build protype to demonstrate the effectiveness of the proposed modifications to enable wider industry adoption of the standard.

**Key features of 5Gi and challenging in adoption**

All of us in the industry agree that cellular network range are limited by the power output of cell phones or UEs. Any effort towards improving the coverage must focus on UE side transmitter and Base station side receiver. Key essence of the 5Gi contribution can be listed as below

i) Introduction of a new waveform that supports pi/2 BPSK modulation with spectrum shaping at the UE side transmitter. Corresponding receiver side algorithms at gNB side is expected to enhance the cell edge performance by 3 dB (2 times).

ii) The new waveform offers enhanced performance on the peak to average power ratio (PAPR). In addition, the waveform is very resilient to non-linearities that offer reduced EVM (error vector magnitude) even when the Power amplifier is driven to saturation.

iii) The new waveform enhances uplink throughput almost by double at cell edge.

iv) The UE transmitter is required to use DFT-s-OFDM in addition to supporting CP-OFDM

From technology perspective no doubt 5Gi is an important extension and has potential for enabling large cell deployments. For adoption of the technology, it is important that the changes are done at both infrastructure side as well as User Equipment side. Teams from 5G test bed have demonstrated the performance in simulation as well as in the laboratory tests with RF. This is an important step in proving the technology but for wider industry adoption it is essential to develop and demonstrate workingprototype5Gi based network in the field deployment scenario.

Below list of points capture the background of challenges for 5Gi adoption and details the efforts by different organizations in addressing them.

a. It is possible to make changes required on base station side to demonstrate 5Gi but there is a challenge in getting the 5Gi support from UE/device side.

b. The device side requires a few changes including a simple filter implementation. Chipset makers like Mediatech, Apple, Qualcomm are important. During the recent visit of Hon'ble PM's to USA, press reports indicated that issue was broached with the Head of Qualcomm for support. IITM is also holding discussions with Mediatech.

c. OEMs are taking it as a matter of principle that 5Gi implementation is likely to enable IITM / IITH/ TSDSI as part of the elite club where they will need to cross license their IPRs for using 5Gi IPRs of IITM/IITH in return.

d. 3GPP, driven by OEMs appears reluctant to enable a few reserved bit fields (called non-critical extensions) for enabling interoperability and co-existence of 5G and 5Gi devices on the same network.

e. Independently IITM has come out with a list of modifications to 5G procedures to implement 5Gi with minimum changes. However, this requires demonstration on the ground. Hence, a campus trial using 5Gi UEs (User Equipment) is the need of the hour to get confidence from the operators.

f. Once 5Gi is made a mandatory standard in India, 3GPP would be compelled to embrace 5Gi as part of the standard. In recently concluded 3GPP meetings, the OEMs appeared reluctant to include it as part of the program plan for release 18.

DoT could offer some incentive for OEMs for Infrastructure and UE who are willing to make 5Gi changes. We propose prototyping the 5Gi leveraging capabilities of Indian telecom Industry players elaborated in further sections as an independent path.

In summary DoT India should adopt both carrot and stick policy to address the 5Gi challenge where one or both the approach may yield results

.

**Proposed Solution**

We propose announcement of a 5Gi Prototyping program that **can have R&D fund for building 5Gi prototypes**. **Multiple consortiums shall be formed led by large government or private companies tasked with responsibility of building Base station and User Side equipment.**

Each consortium to identify partners with technology ownership and start integrating the solution on both UE and BTS. The UE side consortium preferably be led by an integrator with past experience in building chips. Funding should be released respective consortium based on the Technology Readiness Level (TRL) achieved. To ensure competition and better success rate at least 2 consortium each should be considered for UE and BTS.

Each consortium should conduct campus or pilot trials and demonstrate interworking with standard 5G equipment and 5Gi mode interworking among other consortium prototypes.

Successful Base station side consortiums should be allowed to participate in 5G network roll out as a reward.

Successful UE side consortium should be ensured with further funding to build the chipset.

Team worked on 5Gi standard to mentor and support all the consortiums with respect to 5Gi specific algorithms and modifications.

**Spectrum Allocation strategy to promote 5Gi adoption**

**DoT should consider reserving NR band 71 in the range of 663-698 MHz for rural broadband network that implements 5Gi technology. This is a premium frequency band that can give large coverage. With 5Gi, the range can be extended further. This can be a strategy for promoting 5Gi independently.**

To conclude, there is a **golden opportunity for DoT to bind the scattered Indian 5G telecom companies to achieve a common objective of prototyping 5Gi technology and we strongly believe strategic planning around 5Gi technology can pave way for Indian Industry to lead global telecom market.**

# 8.White Paper on Technology Trials and Pilot projects to support domestic telecom equipment companies

## White Paper on Technology Trials and Pilot projects to support domestic telecom equipment companies

As we all know, India is now an evolving hub for the Telecom infrastructure and many Indian companies are capable to not only meet the domestic telecom infrastructure requirements but can even export this equipment once it's established in Indian networks to other countries. But it also a known fact that Telecom networks now days are becoming increasingly complex and needs huge investment to come up with world class products and require market access within the country to get larger pie of the global markets. Trails and pilots are needed in case it's going to be deployed in a network for the first time. It has been observed that existing mode of NCNC (No-Cost-No-Commitment) pilots are becoming extremely difficult for companies to do without clear visibility to end deployment opportunity as any trials/pilots involve large amount of tangible and intangible resources to be allotted from the participating company, which is well beyond the means of any Indian companies.

**National Digital Communication Policy Document states**

a. Creating a Fund for R&D in new technologies for start-ups and entrepreneurs to enable innovation in cutting edge communications, 5G, software, content, security and related technologies and applications, and commercialization of products and services through grants, scholarships, venture capital, etc.
b. Establishing Centres of Excellence including in Spectrum Management, Telecom Security and Next Generation Access Technologies
c. Assisting start-ups and other innovators in filing copyright, patent and
d. trademarks applications
e. Providing financial incentives for the development of Standard Essential Patents (SEPs) in the field of digital communications technologies
f. Creating a framework for testing and certification of new products and services
g. Enabling creation of suitable infrastructure for testing of new products and services with due regard to safety and security concerns

**No Cost No commitment is not the strategy:**
We have been very much familiar with the phrase “No Cost No Commitment” when we talk about field trials or Pilot projects. This is the strategy which has been mostly adopted till date by many of the end customers. But in the current Telecom scenario with newer technologies like 4G/5G, High end Optical networks, complex switching, and routing functionalities involves huge investment in the R&D phase and the later for Trails/Pilots, which as mentioned above is difficult to meet by any companies other than companies with multi-billion-dollar R&D budgets. Till that scale is achieved by Indian companies we request the following support from the government:

1. Govt must fund pilot projects directly or as part of the pre-qualification for a larger market access tender. USOF scheme to fund pilots up to INR 10 Cr especially for the rural network connectivity must be streamlined and promoted to support domestic product development. There should be a nationally adopted list of Indian companies approved by USOF which can be accessed by any operators (TSPs, ISPs) for developing new technologies for Indian requirements. The participating companies will get access to specific amount of funds after an approval by academic expert committee for doing the Trails/Pilots.
2. Govt must come up project plans for large tenders well in advance and must be shared with the domestic Industry. Government should come up with schemes and policies to implement these projects using domestic infrastructure vendors, which may involve additional R&D and product development funding etc. For example, Bharat net Phase 3 project to provide pervasive 4G mobile broadband coverage in all villages of India must be build using domestic products only, whatever requirements and features are desired must be shared with the industry well in advance and enough time for R&D and sufficient money for the trials should be built into the project.
3. Proof of Concept (POC) must be made part of tenders and RFP to qualify the domestic products (in case an Indian vendor has not deployed the same in any network in India or abroad). Rather than insisting on huge deployment experience, POC must be introduced as a qualifying criterion for newer technologies, which are newly developed, followed by business commitment for the successful vendors.

**Infrastructure must be available for the academia or other Govt bodies for Indian companies and startup to do trials and pilots:**

Indian academia and other Govt bodies must be made well equipped with all passive infrastructure, test and measurement tools etc. where any of the Indian R&D companies can use this infrastructure at a reasonable cost and get their equipment tested in campus networks and even can get certifications. Following are the typical infrastructure support needed at these institutes:

1. Availability of spectrum to test various wireless devices, Countries such as Japan and Hong Kong have taken a novel approach to spectrum pricing to promote investment in mobile technologies by assigning spectrum at no cost to operators to promote trials. The Indian government should consider assigning all spectrum (which are yet to be auctioned) with no fees to Indian academic institutes where Indian OEM can get their equipment tested.
2. Availability of towers, power with DG backup and other passive infrastructure along with pre-approved permissions to radiate within the campus. The maximum radiated power can be notified so that there is no misuse of this networks.

3. These academia and institutes must have different modes of connectivity. National Knowledge Network (NKN) must further be extended to provide pervasive coverage within the institutes with a capability for students to develop new applications over the top of this networks. This new applications and ventures can be seeded initially as well through research parks in this campus.

# 9. White Paper on License Free Low Powered Micro Cellular Systems

## White Paper on License Free Low Powered Micro Cellular Systems

DoT through its letter No. 20-281/2010-AS-I Vol.XII (pt) dated 8th May 2019 (Annexure-I), inter-alia, informed TRAI that the National Digital Communications Policy (NDCP) 2018, under its 'Propel India' mission, envisages one of the strategies as 'Reforming the licensing and regulatory regime to catalyse Investments and Innovation and promote Ease of Doing Business'. Enabling unbundling of different layers (e.g. infrastructure, network, services and application layer) through differential licensing is one of the action plans for fulfilling the afore-mentioned strategy.

There is an existing TRAI Consultation vide Reference No. 21/2019 dated 9th December 2019 "Pre-Consultation Paper on Enabling Unbundling of Different Layers Through Differential Licensing" with link as https://www.trai.gov.in/pre-consultation-paper-enabling-unbundling-different-layers-through-differential-licensing

Though more than 2 years have passed, yet TRAI Recommendations are awaited.

OFCOM also had adopted somewhat similar strategy about a decade back.

The White Paper has suggestion to create Indian companies like QUALCOMM who were given spectrum free in early 90 for US invented Mobile system.

One of the differential licensing option can be through adoption of a **license free approach through Micro cellular low powered telecommunication systems** with maximum EIRP up to 4 Watts with FDD access techniques making use of indigenously developed systems and technology. It can be implemented by allocating a small chunk of spectrum in the frequency band 1800 MHz that is presently used by existing wireless users of captive systems subject to using only Indian designed & owned 4G / LTE system. Maximum EIRP of 36 dbm can be as per IND 55 NFAP 2011. Annex A may be seen.

**License Free Low Powered Micro Cellular Systems** will address requirements for **private non-commercial usage** and get further synergies for **Small Sized LTE based mobile systems, with its various derivatives including rural and disaster communications, and NIB (Network in Box)** as was also envisaged in DOT Gazette Notification No. 18-10/2017- IP dated 29th August 2018.

**Test Licenses**

This can be a strategic move. The Authority/ DoT could easily support through provision of **test licenses in appropriate LTE bands to start with.**

India can take the lead and allow, and **support indigenously developed private mobile systems say for a period of 5 to 10 years. Spectrum reservation** can be done for 5+5 MHz in FDD LTE band or 5 MHz TDD LTE band.

Now there are additional bands that are being used by Licensed Service Providers or are part of TRAI Recommendations including for 5G auction and are being planned in various parts of the world including for **private mobile networks.** These include spectrum bands in the 700MHz, 800MHz, 900MHz, 1800MHz, 2100MHz, 2300MHz, 2500MHz, 3300-3600 MHz, 26 GHz, 40 GHz, 50 GHz, and 66 GHz bands for mobile services. **Further studies can be carried out by WPC to identify other right set of frequency slots for ready usage that can support indigenously developed private mobile systems**.

**ANNEX A**

1. **Extracts from NFAP 2011 (September 2011)**

'India Remarks' in the National Frequency Allocation Table (Sept 2011) Foot Notes are as below:

IND 50

Requirements for Micro cellular low powered, telecommunication systems with maximum EIRP up to 4 Watts, FDD access techniques may be considered at specific locations for indigenously developed systems and technology, in a small chunk, in the frequency band 900 MHz presently used by existing wireless users of captive systems subject to co-ordination on case-by-case basis.

IND55

Requirements for Micro cellular low powered telecommunication systems with maximum EIRP up to 4 Watts, FDD access techniques may be considered at specific locations for indigenously developed systems and technology, in a small chunk, in the frequency band 1800 MHz presently used by existing wireless users of captive systems subject to co-ordination on case-by-case basis.

**We can support indigenously developed private mobile systems in the country based on NFAP plan 2011**

A decade back some domestic companies had designed private GSM networks where the PABX was acting as the MSC and all features & functions were configured exactly the way customers were doing it for the PBX. BSC & BTS were configured for RF functions. There was lot of traction from Defense, NDMA, Railways and large PSU "factory cum residential" complexes but eventually no license free approach was not entertained at that time.

**Similar past precedence have existed prior to 2007 for Cordect that reserved spectrum for Indian R&D based products.**

2. **OFCCOM**

**OFCCOM had allowed Low-power concurrent use in the spectrum bands 1781.7 –1785 MHz paired with 1876.7 – 1880 MHz more than a decade back.**

10. **White Paper on CBRS like Licensing System**

# White Paper on CBRS like Licensing System

1. **News Item on FCC's CBRS proposals**

**"FCC to rule on 900 MHz spectrum for private LTE and 5G networks for smart utilities"**

The Federal Communications Commission (FCC) has said it will consider allowing the 900 MHz band in the US to be used by energy companies for private LTE and 5G networking.

The move is a response to a long-standing request by private networking firms to open the 900 MHz band for private usage.

It follows the liberalisation of spectrum for private and shared networking in several markets, which have taken their lead from the **FCC's decision to re-farm CBRS spectrum at 3.5G-3.7 GHz.**

The utility and enterprise ecosystems plan to put this spectrum to work fuelling industrial 5G and delivering the benefits of secure, innovative, private LTE broadband networks. This decision will lead to new jobs, new investment, and new technology development."

**WE can plan somewhat on similar lines for private mobile networks using some of the bands suggested in Para 3 above.**

**There is a news item in Telecom Economic Times of 19th October 2021 as referred in the link suggesting similar approach. https://telecom.economictimes.indiatimes.com/news/trai-may-reserve-25mhz-of-mid-band-spectrum-for-private-networks-report/87132558**

2. **Annex A, has a proposal that was already submitted by some Indian Start ups in May 2021 on which possibly decision is awaited. The present White Paper resubmits the earlier proposal.**

The Paper requests for **allocation of spectrum like CBRS spectrum in US for private enterprise networks in India** also.

**One possible option could be reservation of NR band 71 in the range of 663-698MHz for rural broadband network and 5Gi technology. Annex B is also relevant.**

This is a premium frequency band that can give large coverage. With 5Gi, the range can be extended further. This can be a strategy for promoting 5Gi also for which a parallel White Paper is being submitted.

**Additional Recommendations based on NDCP**

- **Policy to open spectrum bands (either unused or no with product ecosystem) to TSPs making use of Indigenous products**
- **Incentive bands where there are Indian products**

**ANNEX A**

**CBRS Like Licensing Model for India**
**A Proposal from Start Ups**

**Sooktha, Lekha, &**
**Guna Bala Shekar, Ayush Sharma (Industry Expert Contributors)**
3rd May 2021

# 1 Introduction

This note is created by Telecom Industry Startups and Industry Experts as an urgent input to DoT towards the Spectrum Policy formulation for the next ten years. The note recommends consideration of a spectrum licensing and usage model similar to the Citizen Band Radio Service (CBRS) model in the US. The model is a multi-tier model that enables shared and unlicensed access to spectrum.
This note is the first draft being submitted to DoT as an industry representation. The proponents will follow-up with further deliberations within standardisation bodies and make recommendations on this topic as appropriate. DoT is also requested to kindly consider this input and issue liaison request(s) to standardisation bodies and start consultations with Industry as appropriate.

# 2 CBRS Overview

The FCC in the US freed 150 MHz of spectrum from incumbents as a shared spectrum for meeting custom and regional wireless networking needs. The CBRS alliance (an industry association) has enabled the designation of a band by 3GPP for this purpose (Band 48). This band also overlaps with two traditional LTE bands (Band 42 and Band 43) and two traditional 5G NR bands (n77 and n78).
The CBRS spectrum sharing rules were defined to support wireless access to the general public and to protect incumbent users from interference. The protection was critical because the CBRS band is already being used by the US Military and Navy. Asking these incumbent users to give up this spectrum was not an option. At the same time all of that spectrum was actually not being used in many locations.
The CBRS model therefore helped create new opportunities regarding the use and distribution of this spectrum to a broader user base while not asking the incumbents to give up the spectrum. It further ensured the cooperation of the incumbents by assuring them full protection from interference. The model achieved this by organizing the spectrum use into three tiers:

1) Incumbent Access: The first tier is where Incumbents are placed. These are systems such as Navy RADARs, US Military, and Fixed Satellite Stations (Space-To-Earth). This tier has priority on the entire 150MHz (over the lower tiers), but it does not always use the entire band at every location.
2) Priority Access: The second tier is where priority access devices are placed and operate under a Priority Access License (PAL). The license is granted on a county-by-county (high geographical area granularity) basis through competitive bidding. Each PAL consists of a 10 MHz channel within the 3550-3650 MHz band. PALs are 10-year renewable licenses. For purposes of the PAL service, counties are defined using the United States Census Bureau's 2017 counties. Up to seven PALs may be licensed in any given county, subject to a four PAL channel aggregation cap for any licensee. PALs must meet a substantial performance requirement by the end of the initial license term. PALs must protect and accept interference from Incumbent Access users but receive protection from General Authorized Access users.
3) General Authorized Access: This tier is referred to as the General Authorized Access (GAA). This tier is unlicensed and therefore shared. The GAA tier is licensed-by-rule to permit open, flexible access to the band for the widest possible group of potential users. GAA users can operate throughout the 3550-3700 MHz band
4) including opportunistic use of any PAL spectrum that is unused. GAA users must not cause harmful interference to Incumbent Access users or Priority Access Licensees and must accept interference from these users. GAA users also have no expectation of interference protection from other GAA users. However, all of this is managed automatically by a Spectrum Allocation Server (SAS).

## 2.1 Benefits

The following key benefits may please be noted when considering this model for India:

- Reuse of spectrum owned by incumbents while guaranteeing them primary usage. Therefore, any incumbents that are holding this spectrum already may not have to be requested to relinquish it fully. They only need to be convinced to share with the guarantee that there would be no interference.
- Extended range allowed by the provision for both indoor and outdoor deployments therefore allowing for larger range and better Quality of Service guarantee (as compared to WiFi).
- Distributed licensing over smaller geographical areas (much lesser than the “circle” concept used for licensed cellular wireless spectrum). This significantly lowers the licensing fee barrier for new entrants to bid and acquire the license to offer innovative services and applications. At the same time, when accumulated over a large number of such smaller areas, it may represent significant licensing revenue.
- Automated spectrum administration with technology supported real time spectrum administration enabled by the Spectrum Allocation Server (SAS) and Environmental Sensing Capability (ESC) networks. There are already several certified SAS and ESC sensor vendors.
- Maximum utilization of spectrum by allowing unlicensed use of any unused spectrum akin to WiFi.
- Ecosystem support and reliability of cellular wireless networks (Band 48 accepted by 3GPP). There are mature certification programs for CBRS base stations and several popular smartphone models (Apple, Samsung, Google) supporting CBRS bands.
- Significant barrier reduction for “private” LTE networks, local service providers, and therefore MSMEs, SMEs, and Startups.
- Stimulation of applications and multiple use cases with ability for local or smaller scale services and networks to take the lead and establish a model that could potentially be scaled up into commercial networks.

## 2.2 **Key Statistics**

The CBRS Alliance already boasts of Tier-1 Industry representation with companies such as Google, Cisco, Ericsson, Nokia, AT&T, Verizon, Dish, T-Mobile, Comcast, Charter, Cox, and Qualcomm backing the alliance. This section reproduces some more key statistics regarding CBRS from [8].

### 2.2.1 CBRS by the Numbers

- 100k+ deployed CBSDs (CBRS Devices, i.e., CBRS compliant base stations)
- $4.6 billion bid in CBRS PAL Auction
- >100 total number of CBSD models in the FCC-ID database
- >2.5k CPIs (Certified Professional Installers)

Approved Vendors
Certified Professional Installer Training Programs: 5
*To meet the FCC Part 96 rules, CPIs must be trained and certified. The Forum's CPI Accreditation Standard provides guidelines for this procedure.*
Root CA Operators: 4
*Subscribers should install all WInnForum authorized CBRS Root CA certificates in their device trust anchor stores to validate received certificates.*

- WInnForum Accredited Testing and Certification Labs: 16

*To be FCC certified to operate in the CBRS Band, an equipment manufacturer will need to show that their CBSD can communicate with a Spectrum Access System and follow its directives as per Part 96.*
PAL Auction Summaries
Winners
Enterprise Users: 15
Misc: 30
MSO/MNO/MVNO: 22
Utilities: 14
WISPs: 85
Local Telco: 61

- Priority Access Licenses Enterprise Users: 185 Misc: 1,242

MSO/MNO/MVNO: 14,328
Utilities: 503
WISPs: 2,013
Local Telco: 2,323

### 2.2.2 **Key Takeaways**

This section reiterates some of the key takeaways from the auctions [9]:

- The auctions raised USD 4.6 billion from spectrum that was previously deemed unavailable as it was held by incumbents.
- More than 220 companies bid in the auction and won more than 22,000 licenses.
- The top bid was from one of the leading Telco Service Providers in the US, Verizon, at USD 1.8 billion.
- A green field service provider, Dish has the next highest bid at close to USD 1 billion.
- Cable companies Cox, Charter, and Comcast rounded out the top five.
- However, many small Wireless Internet Service Providers (WISPs), companies like Chevron, and even Academic Institutes like Texas A&M were among the bidders and winners.
- There is representation from segments such as Enterprise, Cable, Education, and Industry in the bidders list.

• Further a secondary market of CBRS spectrum is also expected to flourish in the US with several companies offering spectrum “on-demand”.
This shows the diverse interest in this band and the vast array of services and applications it is expected to stimulate.

## 2.3 Market Research Samples

The figure below shows the market share between different types of service providers from an SNS Telecom report [10]:

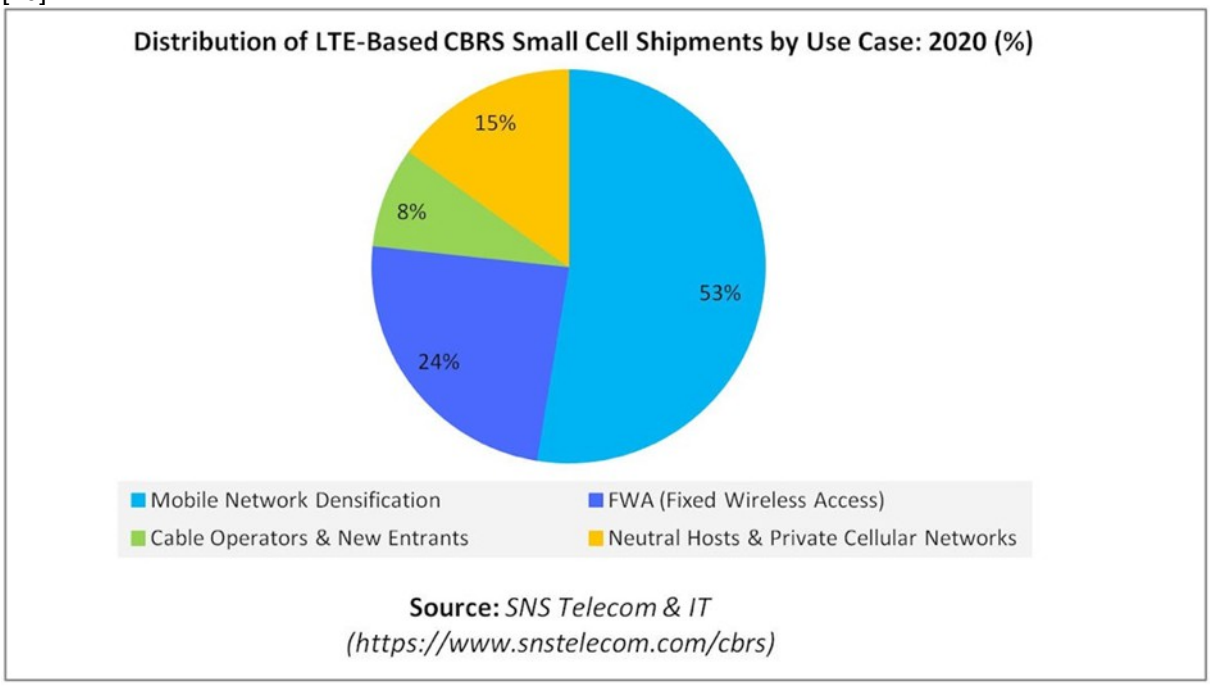



*Figure 1: CBRS Network Usage Segments [10]*

As per the above report, the RAN small cell shipments themselves are expected to surpass USD 1 Billion by 2023. This projection is backed by another report from ResearchnResearch [11]. Another takeaway from the SNS report [10] is that alternate licensing models supplement the licenses owned by traditional Telecom Service Providers (TSPs) by providing them another option for regional and local mobile network densification.

A report in the ISE magazine [12] highlights the significant role CBRS will play in rural, utilities and other private networks.

The figure below is a snapshot of the private networks market based on a Grand View Research report [13]:

*Figure 2: Private Networks Market Snapshot [13]*

Alternate licensing models are required to stimulate this private network market. CBRS networks may be reasonably assumed to capture at least 40% of this market.

As per a former FCC commissioner (see [14]):

- The estimated market value of CBRS ranges up to $15.6 billion
- The estimated annual consumer surplus of CBRS is between $8 billion-$26 billion
- The estimated net present value of consumer surplus is between $80 billion-$260 billion

## 5. 3 Use Cases/Applications

A number of use cases are stimulated by a model such as CBRS. Some examples are provided below:

1) Indoor/Inbuilding
   a) Education
   b) Healthcare
   c) Hospitality
   d) Multitenant units (Apartments)
   e) Enterprises (Offices)
   f) Indoor public spaces (Auditoriums, Malls, Theatres)

2) Outdoor/Public Spaces
   a) Venues (Stadiums, Exhibition Space, Trade Fair Space)
   b) Government Users
   c) Retail Networks
   d) Adhoc (Disaster management supplementary)

3) Private Networks/Industrial IoT
   a) Manufacturing
   b) Mining
   c) Oil & Gas
   d) Utilities (Power, Water)
   e) Transportation

Under each of the above high level use-case categories a large number of applications are possible. The use cases have a potential to stimulate local service providers, neutral host infrastructure, and privately owned networks which may act as platforms for hosting a number of innovative applications. This has potential to go significantly beyond the OTT, smartphone vendor bundled, or Telco provided classes of applications that exist today.

### 3.1 Societal Benefits Examples

Some societal benefits from various use cases are reproduced from a GSMA report [15] in this section. The GSMA report addresses the benefits arising from these use cases in the context of 5G mmWave deployment. However, most of the use cases are just as effectively enabled in the mid-band. Further, both mid-band and mmWave will need innovative spectrum policies to stimulate the ecosystem required to unlock the full potential of these use cases.

**Healthcare**

In healthcare, expanding remote treatment opportunities and using data analysis from wearables to drive better research and increasingly personalized treatment plans can increase access to and the quality of healthcare.

The automation of objects such as smart syringes, supply cabinets, and hospital beds may lead to more efficient management of resources, and reduce the opportunities for errors in drug administration.

Applications such as remote diagnosis and remote surgery may expand access and availability to healthcare by moving the care closer to patients and caregivers without requiring an in-person visit, especially in areas lacking local specialists.

### Education

The provision of high-speed broadband is expected to increase access to and quality of education, especially in cases where online learning opportunities are a better alternative to local classes, or where students were previously unable to access education.

Virtual reality and meeting applications allow skills usually taught in person, like fine motor skills, to be learned at a distance with the help of haptic feedback and high-speed broadband.

### Industrial IoT/Automation

Industrial IoT and automation use cases are expected to significantly improve the industrial production processes in a number of ways. First, industrial automation can enable various components of the production process to communicate wirelessly, thereby cutting down on outages and malfunctions. Additionally, the integration of high-speed imaging in machines can improve quality assurance and data collected by automated machines can be used to proactively prevent faults and modify processes.

Additionally, the remote control of equipment and vehicles (including unmanned ground or aerial vehicles) is expected to increase safety by preventing human workers from operating machinery in dangerous situations, and providing first responders with new tools for reconnaissance and rescue in emergency situations.

Additionally, industrial/workplace education can improve worker safety by teaching skills used in dangerous situations in a safe VR/AR setting. Virtual applications are also predicted to improve production processes by enabling real-time high-quality assistance from remote experts supporting factories or construction sites to solve mechanical or technical issues, or by enabling virtual walk-throughs of buildings for architects and engineers

### Transportation

A number of societal benefits are expected from next-generation transport connectivity applications including increased mobility, shorter commute times, improved road safety, and reduced pollution. Autonomous driving could increase mobility for the elderly and disabled persons and improve road safety by limiting the potential for human error to cause accidents. Intelligent transportation systems that use data from connected vehicles and smart infrastructure could improve commute times and reduce pollution by optimizing pedestrian routes and public transportation.

### Disaster Management

Disaster response is significantly improved by supporting enhanced, secure, mission-critical communications, as well as providing network capacity to support connected ambulances and unmanned ground and/or aerial vehicles. Additionally, it is also predicted to increase safety by maintaining network coverage in heavily trafficked areas—such as during emergencies where there are many outgoing calls in dense areas, and extending service to out-of-coverage areas by leveraging adhoc networks in cases of infrastructure failure.

Additionally, autonomous vehicles or driving assistance for emergency responders could increase safety when driving in disaster areas or in hazardous terrain during rescue missions.

**3.2 Economic Benefits Projection**

The below snapshots reproduced from [15] best represent the economic benefits.

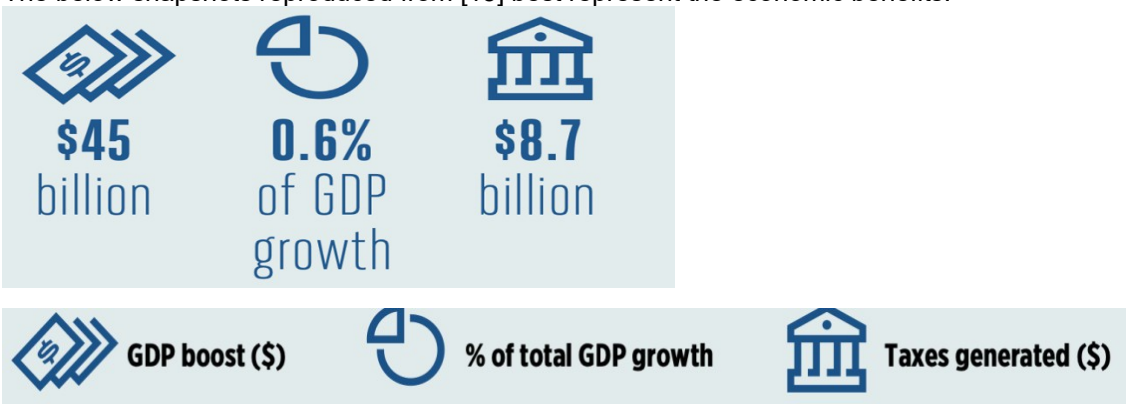



Figure 3: South Asia, South East Asia & Pacific Islands GDP Contribution of Use Cases [15]

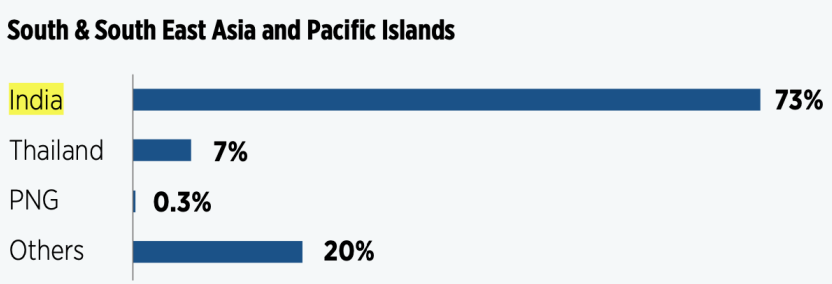
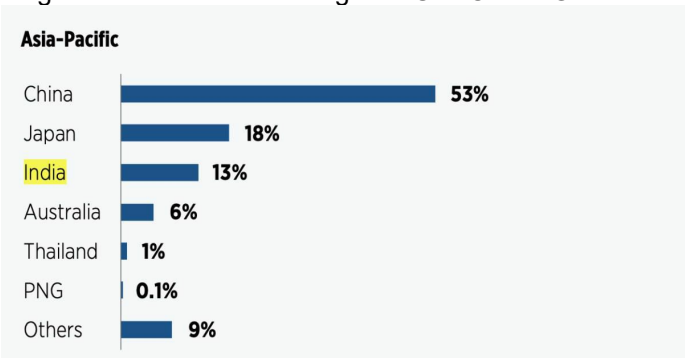



Figure 4: India Share of Regional Use Cases GDP contribution [15]




A very small portion of the use cases listed are being served today by the traditional Telecom Service Providers (TSPs) and by the traditional licensing models. While the TSPs are expected to evolve to support a larger percentage of these use cases they will need new spectrum licensing models. However, this alone will not be sufficient and a larger ecosystem will be required to unlock the full potential of these use cases.
Further while the projected GDP contribution from India is a healthy 73% at a regional level it is only projected to be 13% at an Asia-Pacific level. There is an opportunity for India to significantly improve this percentage and improve its share in the Asia-Pacific and Global levels. Innovative spectrum licensing policies will be one of the keys to enabling this increased contribution.

## 4 India Proposal

The proponents recommend consideration of this model for spectrum policy and allocation in India. The proponents believe that the consideration of this spectrum will be extremely critical from the following perspectives:

1) Stimulate an ecosystem of startups, SMEs, MSMEs and local service providers.
2) Act as an easy first policy step to stimulate “private” networks.
3) Stimulate a plethora of innovative use cases and applications – that may further enable more effective usage of the traditionally licensed spectrum as well.
4) Maximize spectrum utilization by ensuring spectrum is used effectively in every square kilometre of geographical area.

*5) Act as model whose technology (SAS and ESC) may also be used for administering and tracking experimental licenses in future.*

Location information is an integral part of automated spectrum management in this model and the integrity of national networks may be maintained by using IRNSS/NavIC technology for location information.
The model may be considered for bands (low band, mid band, and mmWave) where spectrum may be held by the incumbents such as MoD, ISRO, and Prasar Bharti but not fully utilized in all locations.
The proponents recommend that such a model be considered when planning spectrum allocations and licensing policy for the next ten years. We further recommend that DoT may consider TRAI consultations to seek industry inputs as well as issue liaison requests to standardisation bodies for any necessary studies.
Finally, the proponents suggest that the model may be considered not only as-is but also as also a basis to evolve innovative spectrum sharing and licensing models specific to India.

## 5 Summary

## 5.1 Recommendations

The proponents recommend that DoT consider the CBRS as a model for further evaluation for applicability and evolution in the Indian context and that this be an essential aspect of the spectrum allocation plan and spectrum policy consideration for the next decade.

The proponents also recommend that further information may be gathered via TRAI consultations and by issuing liaison requests to standardisation bodies to conduct studies as a first step. The standardisation and certification bodies may also requested to enable certification as a subsequent step.

## 5.2 Next Steps

This section contains suggestions for immediate next steps. The proponents would be glad to deliberate and make more detailed recommendations on these next steps on request from DoT.

### 5.2.1 Spectrum Studies

The following next steps are recommended:

- Consider existing spectrum used by incumbents for the CBRS model and initiate necessary studies.
- Consider unlicensed spectrum for a migration to the CBRS model (to allow larger range and adoption of cellular model).
- Consider any new spectrum that may not be allocated yet (spectrum that may be already committed to other entities) for adoption of the CBRS model.
- Initiate studies on technical issues where required/appropriate.

### 5.2.2 Use Case Analysis

The following next steps are recommended:

- Issue consultation to get inputs from different segments on their needs and the applicability/utility of CBRS model.
- Initiate studies on use-cases and applications impact of the CBRS model.
- Initiate more detailed studies on the economic impact of such a model.

# 11. White Paper on Community Development, Testing & Certification Infra

## White Paper on Community Development, Testing & Certification Infra

Indigenization of products would require Indian companies to have strong hold of Technology, Testing and Certifications. These will be the primary pillars for creating world class stable products that can be put to use in domestic as well as International market.

Problem Statements –

- High investments involved in research of new technologies
- Product research and development ecosystem
- Recognition of Indian companies developed standards on the global forums
- Huge capital expenditure in equipment to set up test environments
- Centralized Indian certification criteria and standards
- Domestic preference to home grown products
- Policy support to push global exports of Indian make products

Above points can have resolution in the form of Technology funds, by creating Nodal monitoring body, centralized Test lab setup and others….

6. **National Digital Communication Policy Document states**

h. **Creating a Fund for R&D in new technologies for start-ups and entrepreneurs to enable innovation in cutting edge communications, 5G, software, content, security and related technologies and applications, and commercialization of products and services through grants, scholarships, venture capital, etc.**
i. **Establishing Centres of Excellence including in Spectrum Management, Telecom Security and Next Generation Access Technologies**
j. **Assisting start-ups and other innovators in filing copyright, patent and**
k. **trademarks applications**
l. **Providing financial incentives for the development of Standard Essential Patents (SEPs) in the field of digital communications technologies**
m. **Creating a framework for testing and certification of new products and services**
n. **Enabling creation of suitable infrastructure for testing of new products and services with due regard to safety and security concerns**

7. **Technology Fund**

The most crucial part of creating any product is the understanding of technology. For example, With 5G we might be able to understand technology, design and manufacture products but with 6G we can hand hold of the technology itself. We should start now and participate in formulation of standards for the upcoming technologies of the Telecom domain.

Part of the fund should focus on product creation where success can be achieved in relatively shorter time frames and technology may be available with Industry, C-Dot or Academia. These would be low hanging fruits resulting in “quick success” that will spin a positive re-enforcements cycle for product design and commercialization in India. Telecom products like Customer premises equipment, Access products, NMS, Billing software, VoIP products, Network switches, Routers & Media gateways can be classified in this category.
This fund will push Indian companies in

- Design and Product development
- Support of IPR and patents
- Common testing and standardization
- Defining of new standards and technologies
- Early start in the upcoming technologies to mark global presence.
- Support to the extent of 70% of the expenses incurred by Indian design companies on certification from TEC approved test labs.

So a technology Find can be constituted to push organizations to go for defining relevant standards in respective domains.

8. **Testing and Validation**

Testing and validation will be crucial stage to make the Indian make products stable and commercially usable in and out of the country. The need is to develop local capability to assure that certification requirements for Indian IoT/ 5G Products and services must be locally handled under TEC accredited labs, including international certifications such as GSMA SAS, oneM2M, ETSI, CTIA etc. to make sure our made products are suitable for global deployments.
The key asks here are, funding of the Test and Certification Labs, assurance of inter-operability test capabilities along lines of key international standards (including performance testing standards)
**Government funded-test beds for upcoming technologies like 5G, will ensure that “the downside costs are defrayed.”**

- Functional Validation lab

Centralized lab to provide TEC (Telecommunication Engineering Center) support to do Functional Testing which would include 5G/4G (RCT/ORAN/IOT), Wi-Fi , Switches, ONT (Product Functionality as per TEC user manual, Power, Spectrum, Environmental, Surge etc.) and Safety Measure Test (EMC and EMI) for different telecommunication/wireless/networking products.
For simpler products referred to as “low hanging fruits”, Govt funded projects including C-DOT, C-Dac or Academia who have developed or worked in these technologies will have the requisite test and certifying facilities who can be tasked to validate / enhance such products developed by Industry / start-ups. C-Dot can set up a cell whose function should be to ensure validation / certification & enhancement of products developed by Industry in aligned area.
Based on their validation / certification, TEC should be advised to issue a provisional certificate or approval.

9. **Pilots, Technology Trials, Use case labs**

Proper infrastructure and environment would be required to make products ready for commercial use cases.

The key asks here are funding of field trials and pilots through various government initiatives and funding schemes including opening up of the USOF for domestic technology incubation and testing

- Allocation of Airwaves for Cellular products testing
- Product testing and validation in actual network environment
- New technology trials for benchmarking standards
- Realization of real time use cases to make product readiness for the commercial

**Support on the availability and allocation of "Test Space" for RU and Wi-fi Access Point Testing**
To do the field testing of

- 5G O-RAN and 4G Products including Radio Unit (Indoor/Outdoor and Massive MIMO) supporting multiple bands. These products support bands on FDD, TDD and mm Wave etc.
- Wi-Fi Access Points, UBR

10. **Certification**

Lab to perform different testing for security of the product which includes EMI and EMC based testing.

- Reliability Testing and Certification Support in terms of :
- IEC: Safety Section covering all the standards
- Ingress Protection: Including all automated solution and facility
- Telecom: ITU/ETSI/3GPP/ORAN standards
- EMC : Electromagnetic compatibility
- EMI: Emission Testing
- BIS: Bureau of Indian Standard
- BEE: Bureau of Energy Efficiency

# 12. White Paper Covering Telecom Sector issues with Finance, Banking and Revenue Department

# White Paper Covering Telecom Sector issues with Finance, Banking and Revenue Department

This paper brings out a series of Telecom sector issues as relevant for discussions with Finance Ministry **addressing Financial Budget, BANKING and REVENUE including duties and custom Departments.**

We are open for more detailed discussions with the Ministry on any of the following issues. This White Paper is the 10th in the series that are shared with the Government after the interactive session of Indian design/ IPR/ Technology companies with Secretary (T), DoT on 14th October 2021 in addition to new updated draft on Public Procurement (Preference to Make in India) Order 2017 in track change mode.

**ISSUES RELEVANT TO FINANCE REFORMS IN TELECOM SECTOR**

**ISSUES RELEVANT TO possible 'FINANCE REFORMS' covering TELECOM SECTOR are as below:**

1. **Non-take-off of Line of Credit Projects in Telecom Sector despite announcements at highest level**

**Line of Credit Guideline requirements had needed a change on 'Sovereign Guarantee' issue guidelines for Telecom Sector at least after US $ 1 Billion Line of Credit was announced by Prime Minister in ASEAN-INDIA SUMMIT in 2015.**

US $ 1 Billion Line of Credit was announced by Hon'ble Prime Minister during ASEAN-India Summit in year 2015 for ASEAN DIGITAL Connectivity. With more than 6 years being over, not a single Project meeting requirements of Line of Credit requirements issued by Finance Ministry has materialized.

Informally some of ASEAN countries have informed that they have difficulties in SOVEREIGN GUARANTEE as Governments are no longer the Service Provider. Telecom is now in a multi-operator competitive environment in all countries including private sector and at best Government Banks in requesting country can extend letter of comfort. This is the input industry was able to gather after close interaction with various ASEAN authorities. Alternatives to Sovereign Guarantee like Letter of Comfort from Government Banks in requesting country was suggested by some countries at least for Telecom Sector LOCs.

India is already facing an embarrassing situation in ASEAN Summits as there is no new progress. It is high time, we need on urgent footing to tie up all loose ends with no coordinated efforts between various government departments, ministries, and the industry.

## 1.1 STATUS on "DIGITAL CONNECTIVITY US $ 1 BILLION ASEAN CREDIT LINE"

### a. DIGITAL CONNECTIVITY US $ 1 BILLION CREDIT LINE

**During 13th ASEAN-India Summit Hon'ble Prime Minister of India, Hon'ble PM Shri Narendra Modi stated on 21st Nov 2015**

*"We also propose to commit a Line of Credit of 1 billion US dollars to promote projects that support physical and digital connectivity between India and ASEAN."*

**b. Again, Hon'ble Prime Minister, Mr. Narendra Modi attended the 14th ASEAN-India Summit and the 11th East Asia Summit held in Laos PDR on 8 September 2016 and stated**

*"Seamless digital connectivity between India and South East Asia is a shared objective. India committed to Master Plan on ASEAN Connectivity."*

**c. Republic Day Celebrations with ASEAN HEADS OF STATE AS STATE GUEST: January 2018**

As ASEAN India commemorated the 25th year of Dialogue Partnership, India had taken a very unique step and the Republic Day Celebrations was organized with all ASEAN HEADS OF STATE invited as STATE GUESTs on 26 January 2018. Agreements were finalized with CLMV countries for additional Telecom Projects under Grants in aid category. These also are yet to see the day of light. China's track record under similar projects is very fast as was indicated by ASEAN countries during their interactions with domestic telecom stakeholders.

**d. 25-January-2018: Delhi Declaration of the ASEAN-India Commemorative Summit to mark the 25th Anniversary of ASEAN-India Dialogue Relations**

"Reaffirm our commitment to enhance physical and digital connectivity in line with the MPAC 2025 and the AIM 2020 by, among others, availing of the US$1 billion line of credit announced by India to promote physical infrastructure and digital connectivity."

**e. Informally some of ASEAN countries have suggested that they have difficulties in SOVEREIGN GUARANTEE as they are not the Service Providers. Telecom is now in a multi-operator competitive environment in all countries including private sector and at best Government Banks in requesting country can extend letter of comfort. This is what the industry can gather after close interaction with various ASEAN authorities**Line of Credit Rules especially on Sovereign Guarantee on Digital Connectivity Projects.

f. Not a Dollar is spent on Telecom Sector Line of Credits for Bangladesh so far. Proposals from Mongolia, Nigeria also is yet to be taken up.

**Recommendation:**

**It is high time, we go into details and see why we have failed miserably on Telecom LOCs. If required issues like alternative options to Sovereign Guarantee in Telecom sector can be identified.**

## 2. Pending implementation of Telecom Finance Corporation

Implementation of Telecom Finance Corporation that was visualised in National Telecom Policy 2012 document by the Government is yet to be taken up though it could have supported Atma-Nirbhar Bharat through easy financing for CAPEX induction by domestic telecom manufacturers.

With Banks having taken a hit on Telecom Service Provider front loans, they are reluctant for another telecom sector entities of Telecom manufacturing. The Policy statement is still relevant and could be the starting point for India to be a Global ICT player in coming months.

Section 12 in NTP 2012 as below directly refers to TFC.

**"12. FINANCING OF TELECOM SECTOR**

12.1. To create a ***Telecom Finance Corporation*** as a vehicle to mobilize and channelize financing for tele com projects in order to facilitate investment in the telecom sector.

12.2. To endeavor to include telecom sector projects within the ambit of financing from existing entities.

12.3. To rationalise taxes, duties and levies affecting the sector and work towards providing a stable fiscal regime to stimulate investments and making services more affordable."

The implementation has relationship with many other Policy issues are very slow in being addressed by concerned authorities and include Design in India, Domestic R&D, Make in India, Digital India, Indian IPRs, low levels of procurements by Indian Licensed Operators, big difference between Exports & Imports, real danger of ICT sector imports being higher than petroleum sector in coming years unless TFC along with associated **rationalisation of taxes, duties and levies affecting the sector along with changes in line with NTP2012 and National Digital Communication Policy that can** stimulate investments, are fully supported.

3. **Banking and Financial Sector** : **'Networking Implementation Plans'**

Banking and Financial Sector are witnessing massive **'Networking Implementation Plans'** deploying Switches, SDVAN, Routers etc. In the background of Security, maintaining secrecy of transactions and related issues, these implementations should take place through domestic telecom networking players with Indian designs, software, IPRs, R&D etc so that real ;MAKE in INDIA' and Atma-Nirbhar Bharat implementations only take place.

4. **Direct Funding Support for SMEs in Telecom Sector**

Financial norms, accountability rules are required to be framed so that direct funding support for SMEs in the private sector is made available in telecom sector that has a long gestation period.

5. **R&D FUNDING Framework for Telecom Sector**

R&D funding framework exclusively in telecom sector for new technologies taking note of risks involved and success not guaranteed. Indian market size by virtue of sheer population is very important as success will ensure manifold returns on R&D investments made. A detailed White Paper on this is already submitted as a follow up of 14th October 2021 meeting with Secretary(T), DoT.

6. **Turn Key Project Implementation**

Department of Expenditure under Ministry of Finance is critical of implementation of Public Procurement (Make in India) policy on "turnkey projects" on the ground that it could delay implementation of large projects involving diverse products. They also argue that implementation agencies may have difficulty in evaluation of domestic value addition on each item of purchase. Problem with turnkey projects is that they involve large amount of civil work that often constitutes more than 50% of the value and is traditionally domestic. In such situation implementation agencies consider civil work as significant domestic value addition and end up buying all the imported electronic and telecom equipment. To address issues for both sides it is suggested that department of Expenditure, under Min of Finance, must issue instructions that in all turnkey and works projects, implementation agencies must ensure that all such items that are earmarked by nodal ministries for procurement from domestic companies because sufficient competition and capacity is available in the country must be procured from domestic manufacturers only.

7. **Treatment of Telecom as stressed and high-risk business**

As per RBI circular of 18th Apr 2017, telecom sector is considered as stressed and high-risk business. Banks use this classification and manufacturing companies suffer on account of being classified under this category. Telecom product manufacturing companies that cater to Customer Premises Equipment (CPE) or Enterprise products also suffer because of this classification. Telecom manufacturers supply telecom products to Corporates, Railways, Défense etc and some of the SME units don't supply anything to the telecom network operators but they suffer because of such classification. This needs correction.

8. **Waiver of Multiple Bank Guarantees**

Waiver of Bank Guarantee for Telecom Service Providers recently. It needs to be extended to PSUs like BSNL wherein each tender has its own Bank Guarantee and that too for all Licensing areas. It gets repeated when it is new product. Huge funds get blocked.

9. **Timely payments in Government Telecom Projects**

Projects like Bharat Net have very poor track record of no payments, delayed and blocked payments especially when PSUs like BSNL are involved.

10. **Demand Creation through idle Spectrum Bands**

There are many Spectrum Bands that are lying spare. Can we not make use of these bands say for time periods of say 5 years and allow industry to do design & development activities around these bands and trigger generation of demand.

11. **Inverted duty structure for specific components**
**Exemption under Notification 50/2017 dated 30th June 2017**

- The import duty on the components used in the manufacturing of certain products under 8517, stated that "If the importer follows the procedure set out in the Customs (Import of Goods at Concessional Rate of Duty) Rules, 2017". The effect of this notification was that all components, irrespective of their classification, used for non-ITA products, falling under 85176290 and 85176990, such as Optical Transport Equipment, OTN products, POTP or POTS products, PTN products etc. got the benefit of exemption.
- Vide Notification 02/2020 dated 2nd Feb 2020, duties on the PCBA for many Non-ITA Telecom equipment products under 8517 have been introduced. However, the exemption for other components provided under Not 50/2017 and 57/2017 continued subject to following procedure set out in the Customs (Import of Goods at Concessional Rate of Duty) Rules, 2017.
- **But vide Notification 03/2021 dated 1st Feb 2021**, **the S. No 8 (v), (vi) and (vii) of Notification 57/2017 have been omitted** which means that for importing components used in the manufacturing of non-ITA products full duty must be paid. It may be argued that S No 5 of Not 57/2017 still provides exemption to components used in manufacturing of all goods. But the hitch is that such components must fall under tariff Item 85177090. Therefore items, which are classifiable under 85176290 or any other HS Code, if imported for use in non-ITA products such as POTP equipment, the same would not get the benefit of the Not 57/2017.

**Recommendation**
Till the time there is no component Industry available in India, no duty should be levied on the components for goods falling under 851762 or 851769, for the domestic manufacturers who own the finished products IPR in India. For the same Government may continue to grant exemption "If the importer follows the procedure set out in the Customs (Import of Goods at Concessional Rate of Duty) Rules, 2017".

12. **Issues related to Custom Duties**

Non implementation of the Custom Duty (2014) notification is an issue faced by industry. At that time all items under HS classification 8517xxx were exempt from payment of duty. This notification made an exception by exempting VoIP, Optical, RF and Carrier Ethernet products from payment of duty which effectively meant that import of these products were to be subjected to customs duty from the applicable date. This custom duty was initially10% and subsequently as per notification dated 11 Oct 2018 was increased to 20%. Objective of the notification was to promote domestic manufacture of these new technology telecom products based on technologies that did not exist when ITA 1 agreement was signed by India.

Problem is that notification has levied customs duty based on functional parameters of the product and in the same HS classification there are products with these functional parameters and without these parameters. VoIP switches & Carrier ethernet products are imported under 8517 69 30 (router) which is exempt from duty, similarly GPON & VoIP phones are imported as 8517 69 50 (subscriber end equipment) which is also exempt from payment of duty. There exists no specific HS classification for items covered in notification of 2014 and 2018.

To implement the spirit of these notifications, there is a need to specifically highlight this aspect in the custom tariff against 8517 69 30 (router) 8517 69 50 (subscriber end equipment) where custom tariff specified in column 4 is "Free". Description of goods in column 2 of the tariff for HS 85176930 will have to specifically write "Routers not including those supporting voice communication" and description of goods in column 2 of the tariff for HS 85176950 will have to be "subscriber end equipment not including those supporting voice communication"

An example is given below through customs data that show import of VoIP PBX as 'Intelligent data router". Description includes words like FXS & SIP which is nothing but VoIP PBX, but goods are cleared without payment of customs duty.

| BE_Date | HS Code | Product Description | Importer Name | Exporters Name | Standard Qty |
|---|---|---|---|---|---|
| 25-Nov-19 | 85176930 | INTELLIGENT DATA ROUTER 32 FXS 96 SIP (IPX22K-9032LW) (USED IN ROUTER, DATA ROUTER & VOICE ROUTER) | CLIXXO BROADBAND PVT LTD | GUANGZHOU ONETOUCH BUSINESS SERVICE CO. LTD. | 100 |
| 02-Jan-20 | 85176290 | INTELLIGENT DATA ROUTER 32 FXS 96 SIP (MDL-IPX22K-9032LW) (USED IN ROUTER, DATA ROUTER & VOICE ROUTER) (USE IN WIRED) | CLIXXO BROADBAND PVT LTD | GUANGZHOU ONETOUCH BUSINESS SERVICE CO. LTD. | 100 |
| 02-Jan-20 | 85176290 | INTELLIGENT DATA ROUTER 32 FXS 96 SIP (MDL-IPX22K-9032LW) (USED IN ROUTER, DATA ROUTER & VOICE ROUTER) (USED IN WIRED) | CLIXXO BROADBAND PVT LTD | GUANGZHOU ONETOUCH BUSINESS SERVICE CO. LTD. | 100 |

13. **Other Issues**

There are some issues that need direct interaction of Finance Ministry with domest IoT solution providers. They can have more inputs from industry on FinTech & other IoT linked payment schemes:

a) UPI needing 4G is bottleneck at times.
b) Payment gateway integration for FastTag – access to FastTag credentials for IOT solution providers.
c) Google/ PayTM apps using UPI interface show value data for these companies like account balance which is without user consent and undesirable.
d) RF ID sensing vs Smart networking combined with GPS based location
e) Alternate FastTag improvements that can remove congestions and traffic jams at tolls.

# 13. The Role of GPS/ NavIC (IRNSS) Satellite Synchronization in the 5G Network

## The Role of GPS/ NavIC (IRNSS) Satellite Synchronization in the 5G Network

With the rollout of 5G, synchronization in carrier networks is becoming even more critical. Mobile cellular networks need to be synchronized to avoid base stations with shared coverage interfering and disrupting each other, leading to declining network quality for customers. Throughout the Third Generation (3G) cellular communications, the NodeBs relied on GPS satellite communications for synchronization, which is also the same case with the Baseband Units (BBUs) in 4G cellular communications. Until now, most mobile network operators (MNOs) have relied on the Global Positioning System (GPS) satellite constellation for synchronization, as satellite antennas have high speed and accurately timed pulses.

Background Inputs

1. Normally drift rate of Local Oscillator in any of the system is vulnerable. As the time progress, drifting rate will be high and different in each system. This will affect communication between systems. To maintain common time & frequency in all systems, reference time source is required.
2. Best economical reference time source is satellite-based system (i.e GPS/ IRNSS/ GLONASS receiver) and this receiver provides common time to all client systems through IEEE 1588 (PTP) and NTP protocol with an accuracy of Nano seconds /Milli seconds. GNSS satellites will have atomic clocks which are high stable and there will be continuous monitoring and updates from Ground control station.
3. All GNSS constellations will have dedicated Time scale in the respective country to maintain high stable and accurate time on satellites, however difference is number of visible satellites in any of given location. In GPS, at any point

of time, maximum visible will be 10 to 12, where as in IRNSS, total available satellites are only 7 and all are visible to Indian continent and surrounding countries. ISRO is having plan to increase this 11 in upcoming days.

Because of this number, there will be difference in Position accuracy on each constellation, but there will be not much impact on IEEE 1588 and NTP accuracy. By using dual frequency GNSS receiver, position and time accuracy can be improved. Today we are getting 1 PPS accuracy with 20 ns and IEEE 1588 with few nano second accuracy.

Updated Synchronization Requirements for the 5G Network

With the 5G network coming into the picture, the speed requirements will increase substantially, so radios will need to be placed closer to the users. More antennas will need to be installed so that signals can overlap, and more interference can be detected. The latency in exchanging data and messages across the network decreases, which would pave the way for newer technologies such as autonomous vehicles. This is called the Ultra-Reliable Low Latency Communications (URLLC).

Lastly, the network needs to support an exponential number of devices, especially for the Internet of Things (IoT) to occur. Massive Machine Type Communications (mMTC) must be supported by the 5G network. The direct implication of this is that more sub-frequencies will need to be used, as many devices will communicate systematically and continuously. However, more sub-frequencies will increase the risk of signal interference, which is why the timing and synchronization techniques used in the cellular network will need to evolve to adapt to the new requirements of the 5G network.

The predecessors of the 5G network, the 3G and 4G networks, embedded satellite receivers in NodeBs and BBUs. These controllers take the time-of-day messages and propagate them over the air to UEs. To keep all cell towers' frequency synchronized, they also take the accurately timed pulse received every second (1PPS). Both the 3G and 4G networks need a line of sight to only one satellite to frequency synchronize.

With the 5G network, the satellites are used slightly differently. The time-of-day messages will still be received and sent over the air to UEs and the Distributed Units (DUs), the controllers used in 5G networks. To stay frequency synchronized, the DUs will also use the 1PPS received from the satellite. However, there is a second use to the time-of-day messages: to keep overlapping cells phase synchronized to avoid interference. A line of sight to multiple satellites will therefore be required to achieve this type of synchronization.

**Why Does GPS/NavIC (IRNSS) Satellite based Time Synchronization in 5G Matter?**

**Timing and synchronization is everything in 5G**

For a mobile network operator, timing is everything. Not just determining when to upgrade the network to bring new services to market, but in the literal sense as well. If the radio clock loses synchronization accuracy in a radio access network (RAN), or the radios are out of synchronization, interference between cells is likely. The less accurate the clock source, the higher the probability for time shifts. Ultimately there will be performance challenges. This issue wasn't a significant concern in legacy networks, but as we transition to 5G it becomes a really big deal.

To use available spectrum as efficiently as possible, 5G technology introduces a time division duplex (TDD) environment. Here both uplink (UL) and downlink (DL) use the same radio channel. Consider this: operators need large amounts of spectrum to deliver on the enhanced mobile broadband (eMBB) use case of 5G, amounts much greater than the 5 to 20MHz that is generally available for LTE networks. Further, most of the available wideband 5G spectrum is either in the C-Band or mmWave, which only supports TDD. This means that TDD is a key factor in enabling eMBB services.

**Complexities in terms of synchronization**

Because a lack of synchronization in UL/DL frames further exacerbates interference problems, industry standards introduce stringent restrictions on LTE and 5G new radio (NR) TDD transmission. While the absolute time synchronization margin in a frequency division duplex (FDD) LTE environment is in the magnitude of 10µs, in the TDD radio environment it is restricted to just 1.5µs. In addition to the absolute time error margin, another consideration is management of over-the-air synchronization requirements for advanced radio features. These include MIMO, eCIC, COMP, and location-based services. In 5G, we are moving away from a synchronized fronthaul CPRI to a packet-based fronthaul. While this approach offers several advantages, packet-based fronthaul introduces complexities for synchronization. Providers need different approaches depending on the topology and configuration of their networks. In most cases, we expect to see precision timing protocol (PTP) for distributing time of day (ToD), and Synchronized Ethernet (SyncE) for distributing frequency. This means that radio units (RU) will be synchronized over Ethernet.

**A test of time, synchronization requirements**

Providers can implement various methods to meet these stringent phase and time synchronization requirements. The intent is to ensure synchronization of all nodes to the primary reference time clock (PRTC) source However, the location of the source may vary depending on the network topology, cost, and application. By using a grand master clock synced to a satellite source (GPS/NavIC satellite based Grand master clock). and a combination of boundary clock and slave clocks, network nodes can be aligned to a common time and phase. For networks that cannot adhere to full timing support, such

as networks that are not PTP aware, there are other options. For example, network operators can implement assisted partial timing support with appropriate consideration for the network topology and cost.
Lastly, it's important to consider the use cases for frame and slot synchronization. 5G 3GPP standards defined 56 slot formats, each of which is a predefined pattern of downlink/flexible/uplink symbols during one slot. These formats allow flexibility in terms of the application supported on a 5G node B (gNB). Yet, this also creates a challenge if two networks offering different types of service are located next to each other. Interference can result even if they are synchronized in time, but their slot formats are not synchronized. Essentially, when operating a 5G or 4G LTE network in a TDD environment, we not only need frequency and phase synchronization, but also frame and slot synchronization. This avoids inter-network interference

**Conclusion**

Synchronization is fundamental to the performance of a cellular network and the services it offers. Both 3G and 4G cellular technology required frequency synchronization, primarily to prevent interference when cells overlap. But with the introduction of 5G technology, we've reached a new level in terms of TDD phase and frame synchronization. Validation testing is essential to meet stricter synchronization requirements and to ensure quality of service.
Any Indian company who are developed dual frequency GNSS receiver including NavIC is an IPR and using this if they develop reference time source, then complete system will be under Make in India category. This should be criteria to select Indigenous system for Time & Frequency synchronization.

# 14. Implementable ideas to create Atmanirbhar Bharat in Telecom Chips : Fabless Telecom Chip Industry

6.

# Implementable ideas to create Atmanirbhar Bharat in Telecom Chips : Fabless Telecom Chip Industry

## 7. Semiconductor Technology in India: The forgotten future

India at some point of time ignored the need to build its prowess in the semiconductor technology. Rest of the world realized that all the electronic systems are getting into Integrated Circuits and the data creation, manipulation (compute), communication, control of infrastructure and rendering to human interfaces all would be through these ICs. There have been huge strides taken by the western entrepreneurship driven ecosystems in the past 3-4 decades and by some eastern establishment driven ecosystems in the last couple of decades in this domain. While we in India have not created these, over time we have become significant consumers of all this technology. It is ironic that it was Dr J C Bose on Indian soil who invented the first communication receiver on a diode nearly 120 years back and India at this time does not own much of this technology. A billion phones, many billion gadgets, not a single our own!! While we have been smart to invest into some strategic technologies like space and atomic energy, for some reason we have failed to foresee the criticality of semiconductors that in fact are integral components of even those strategic technologies. Lack of a minimum level of capability in semiconductor technology will also hold us back in all cutting-edge technology areas like Aerospace (e.g. Drones), Artificial Intelligence, IoT, Data Sciences, Communication, Industrial automation, Transportation and even areas like Medicine and Biotechnology. It's a future we forgot to work upon. Now it is so late that without serious intervention by the establishment, we might be lost forever. In this paper we examine how a fillip can be given to this ecosystem so that this gets addressed at least in the future.

## 8. Outline:

Before going into the steps that are possible to do this, it is imperative that we look at how the rest of the world has fared in this and has come up; so that we can learn the size of the problem we are facing and maybe derive some methodologies and insights about how we can approach a catch up.

I must warn here that this discourse will contain some serious technology components referred so that a person with ordinary education in general sciences might also find tough to comprehend. I have been asked in the past to suggest the solutions in "common man parlance". While I will try my best to keep it that way, I am afraid that such an effort may be as futile as asking a common man to conduct a complicated surgery. What we need are people who can understand the technology as well as the tact and management/leadership capabilities to bring about a change.

## 9. The Western History

Over time, the western ecosystem evolved taking one step at a time. I would have to include Japan as part of this portion of history as well. An electronic system consisted of a circuit board consisting of many components and working in unison. The basic components used in such circuit board are

a. Passive components like resistors, capacitors, inductors, transformers, relays etc.

b. Active components like diodes, bipolar transistors, FETS

And we can make some of these in some primitive way in India. Over time material sciences research have made these components also very sophisticated.

At some point of time, the concept of integrating multiple such components in a silicon wafer was invented by Texas Instruments and over the decades millions and billions of components have been put in one piece of silicon. The earlier integrated Circuits were simple. Year on year, the semiconductor companies took incremental steps and made more complex integrated circuits. This is an important factor to comprehend in the economic cycle of this evolution. It cost a private company little more to make an integrated circuit compared to an active component. They could build that and a business around that and enough R&D money to create the next integrated circuit, a little more complex. All these advances were first consumed by their own defence requirements, almost providing a guaranteed market. After a delay, others in the world consumed these. Over multiple such cycles, there were a few large companies like Intel, Texas Instruments, National Semiconductor, ST Micro that could design complex circuits and put them on one piece of silicon, i.e. fabricate the designed circuit and sell them in reasonably large numbers to sustain the next R&D cycles. As this progressed, the complexity of circuit design could not be handled by manual methods and Automated Computer Aided Design (CAD) methodologies were invented. Similarly, the fabrication and manufacturing also became sophisticated. However, the complexity and cost of both these activities started becoming much larger. So these companies started having two distinct types of activities

a. Design of complex semiconductor chips
b. Fabrication of highly integrated chips

It's almost like a newspaper company, one major activity is to gather all the necessary news, write the articles, edit them, lay them out and prepare for printing, the other activity to print it (and invest R&D on next best printing press for future).

Many semiconductor companies initially did their own CAD and automation tools. Eventually, some companies were founded to purely supply the EDA and CAD software tools to the Semiconductor companies. Also, the economics of fabrication soon became so large that keeping a fabrication setup running within a semiconductor company became unviable for most of the companies. A fab would take millions of dollars a week to just stay on. One cannot switch them off and on at will since it takes long time for a fab to switch on and reach reliable production. So, a new model of outsourced fabrication (similar to media companies outsourcing the printing) took off creating an ecosystem of companies centered around the Fabless Semiconductor Companies

a. Fabless Semiconductor Companies
b. EDA and CAD companies
c. Fabrication houses
d. Packaging and test companies
e. Semiconductor IP Companies

Once the Fabrication was outsourced, a new industry of Semiconductor IP companies that create

components for the use of Fabless Semiconductor Companies came in. TSMC, Global Foundries, UMC are a couple of Fabrication Houses; Qualcomm, Broadcom, Marvell are some notable Fabless Semiconductor companies. The Fabless Semiconductor Companies focus on all the circuit design and layout of the application while the Fabrication house creates the "masks" (like the printing plates) and then mass manufactures the chips. Nearly all the new Companies in the world founded after the 1990s and selling chips are Fabless Semiconductor Companies. Interestingly again, the first company in the world founded in this manner was Cirrus Logic, a fabless semiconductor company founded in the Silicon Valley by Dr. Suhas Patil, an entrepreneur of Indian origin. On the post silicon fabrication activities, companies like ASE, Amkor, Statschippac are a few examples of the packaging and test companies.

10.

## 11. The Eastern Foray:

While this happened between 1980s and 2000 in the west, many of the manufacturing friendly eastern countries like China, Malaysia, Singapore, Philippines, South Korea etc. attracted the Western semiconductor companies to set up their manufacturing bases in their countries. Skilled and cheap labour, productivity-oriented policies and work culture and the clear will power of the Governments of their countries made this possible. While the packaging and test activities started first, eventually with TSMC, even the semiconductor manufacturing moved into the Eastern world. However, the real ownership of chips beyond Japan was not present before the turn of the millennium, in the last 20 years, companies from Taiwan, S. Korea and China have started in the fabless model and owning chips. With a high degree of intellectual capital, India has attracted almost every company in the world to set up its design houses, exporting services. This model unfortunately does not lead to any ownership of the products in the country unless the intellectual capital decides to build Indian owned chips.

## 12. Start-up: The Big Company Effect

Let us see how the new efforts picked up in the last 40 years across the world. If we need to start catching up, we must study how the others did. The Fabless model started by Patil Systems Inc. in 1981 (Cirrus Logic) paved way for many new companies that could own a chip without having to own a fab. In the next 20 years many fabless semiconductor companies were founded. Also, the fact that each chip was small and low in complexity made it easy for companies with a decent small idea to launch business and try out their luck without burning too much money or wasting a lot of time. However, by 2000, the increasing complexity of design and the costs of outsourced fabrication in advanced technology nodes started making the semiconductor start-ups look like white elephant calves. One could no longer make a new company based on a novel component like an amplifier or a processor. A complete System on Chip had to be built. One had to invest USD 50-100Million to make a fabless semiconductor company take off. By around 2005, semiconductor funding in the Silicon Valley started drying up, the downturn in 2008 being the death nail on this. With the commoditized chips being mass produced in east Asian fabs, the industry adapted the cost of production plus margin model and drove itself to the bottom of the price pit. The enormous R&D costs could only be justified by a very few companies. The industry started drifting towards "winner takes all" model. Consequently, the last 10 years saw a continuous series of mergers and

acquisitions with large companies coming together and creating larger behemoths. All these have created a massive entry barrier for anyone trying to enter the semiconductor business. The challenge is higher for companies from India which are trying

to open their eyes now. Being 50 years late means one must clear a major backlog. The thing about chips is that a commercially viable product must be backward compatible many times. If you buy a 5G phone, you still want it to work on 4G/3G and even 2G networks. System on Chip is not enough anymore. Multiple Systems on Chip is the order of the day. It is very clear that strategic interest is a necessary ingredient to start now and build chips. But anyone with strategic interest cannot wait any further, the gap increases every day.

## 13. What has happened in India?

As mentioned earlier, India has been a major contributor to the design of chips owned by rest of the world. While most of Indian talent is engaged in the implementation of the chips, very few have exposure to the conceptualization phase (where technology and business ideation happens). India has significant backlog to catch up

Foreseeing the need for this, some companies like Saankhya Labs, Signalchip, Cirel have braved into this field. They have built chips under such hostile environment for chip building and have been a saving grace on an otherwise bleak history. There have been a few Indian companies building IPs for the consumption of semiconductor product companies which also find it difficult to survive due to the shrinking number of potential customers thanks to the recent consolidation.

Also, there is a misconception that owning chips means “manufacturing in India”. It does not take too much of education to know that most chips in the world are owned by fabless companies. While it is important to manufacture in India, this approach is like focusing on the printing press and not bothering about the ownership of newspaper. In fact, the few chips owned by Indian fabless companies are not even considered as local contents within the policy frameworks of indigenization policies like Make in India etc.

This has had a slowing effect on focus on fabless chip ownership and has been detrimental to real chip ownership. This all or nothing thinking of “Since the ownership arises only when we manufacture, and manufacturing is a very expensive effort let us not think about fabless effort this until that is done” is like saying “Since the printing press is an expensive thing, let us import our newspapers also”.

Even if a fab is built in India, as explained in the earlier sections, different types of chips will require different technology flavours that, it is unlikely that in a foreseeable future, all Indian designed chips will be manufactured in India.

## 14. What needs to be done?

### 1. Remove Hurdles:

Owning a semiconductor chip is almost always through the Fabless model. This is how most chips will be created. Educate the policy makers about this. Call Chips owned by Indian Fabless companies as Local Content. Treat these chips as Indian in all respects.

Also, many simple tasks like shipping fabricated chips, packaging etc. face extremely complicated customs/export/import restrictions that the founders are mostly spending time breaking their heads over

finding out clean ways to send courier etc. Please see Annex A for detailed explanation and suggestions on specific solutions to this issue.

2. Use the platform already built: Help existing few to survive and take the next steps

The existing companies have created some remarkable chips by somehow sticking to it and innovating around the barriers. Saankhya has augmented its chips with system business to reach revenues. Signalchip is trying to innovate around Moore's law to create chips at low development cost. WiSig is making chips for IoT in collaboration with academic institute IITH. Almost all these companies have founders and dedicated employees that work at a fraction of their market salaries to keep the story on. However, they have created multiple systems on chip that are world class. They have covered the backlogs in some fields. It is important that we utilize this platform and help these companies take the next steps. These companies can now take up development in strategic areas like 5G, SDR etc. Adding 5G chip development by private industry as part of the 5G testbed project and providing them with some R&D grants to speed up the development would be the best win-win outcome at this time.

**3. Understand and acknowledge the real costs involved**

Chip design is not cheap, not even close to it. While it is not as expensive as setting up a fab, it is still seriously expensive. It is important to understand the amount of money needed to design and bring a chip into market if we need to do anything about it. Even with Indian "inexpensive talent", chip design is costly. The following table summarizes an indicative cost of R&D for development of chips in 40nm node. The newer competitive nodes will be more expensive.

| Type of chip | Examples | Indicative R&D Cost (INR) |
|---|---|---|
| Small Single Function | GNSS, IOT end point | 25Cr-35Cr |
| Medium Size | Low end WiFi, Wireless Transceiver | 50Cr-70Cr |
| Typical SoC | Modem, SDR | 120-150Cr |
| Large SoC | Compute Processor | 200Cr -250Cr |

The following chart shows the relative expenses of a typical chip development

Any incentive program needs to keep this quantum in mind. Typical development cycles from inception to market readiness are two to four years.

### 4. Making the economics work

Let us take a chip development activity costing 20Million $. Even if the Government is ready to help 50% of this amount, it would be difficult to find entrepreneurs and investors risking 10M$ on a chip idea these days. Commoditization is a major challenge chip companies face. Many chips we use have been selling in huge volumes that the prices have become commoditized. Chips have become commoditized leading to the following paradigms…

- Extreme investment to make cheap chips
  - High value for company, low value for chips
- Poor business case unless a company can be sure of millions of chips if this

is the case,

- What is the motivation for investors to invest into chips in India?
- Left to its own, this industry will not take off in a poor nation like ours
- Will we ever be “ATMANIRBHAR” (do we need to be)?

While this chip price is a market dynamic (which seems to be correcting a little in the 2020-22), many large software corporations and countries have understood the strategic importance of owning the technology at core level and started building their own chips. In fact, due to this disparity present in the general semiconductor industry, even the worldwide chip design activities are now happening within larger software giants like Amazon, Google, Microsoft etc. Large OEMs like Apple and Samsung also do their own chip design. They do this strategically since there is a larger gain seen elsewhere in their business. For example, Google did an AI chip so that its expenses on its servers were reduced significantly.

India uses billions of chips, especially in telecom. Day to day life, economy, security, “rozi roti” of billions depends on chips. As a country, India has a lot of strategic requirements for owning a bunch of semiconductor chips. In fact, when aggregated at the level of the entire nation, even the economics work

out very well. We will need to convert these national level strategic requirement and economic opportunity into a business opportunity for Indian Industry to make new people venture into this field.

### 5. Help new companies to come up

Today, the chips getting funded in the international VC funding area are very high-end ones for AI/ML and data centers. But from a security perspective, there are a whole lot of chips that we use currently on

which it would make sense to have Indian ownership but might not be viable for a new company to sell its business plan to investors and itself. As an example, a lot of data in India moves on Wi-Fi chips. Wi-Fi chips sell at <3$ apiece. Assume an investment of 10-15M$ on this chip, it would take a sale of more than 10M units to make ROI assuming a 1$ margin. It would be very difficult for a VC to make investment on this business plan. Even the founders will shy away. But this technology is ubiquitous and newer versions of these standards for Wi-Fi will keep coming, new chips will be made by the incumbents at incremental costs, and we will keep using them for long time. The gap will grow further making it more difficult to justify a later catch-up activity. As a country there is a strategic need. If this can be presented as a business opportunity to the Indian companies, a couple of them might develop them with the hope that the IP would be useful for future chips. Subsidizing the sale of chips by Indian companies is another method. It is important to ensure that chips incentivized thus are going to be competitive in the global market from a definition, quality and performance perspective, so that once the catch-up is over, they sustain in the free market.

### 6. Encourage/incentivize top talent to work in Indian MSMEs.

Chip design is a highly specialized effort and requires some of the best engineering talent to work on it. Largest expense faced by R&D oriented activity like chip design is paying top talent that choose to join high paying jobs. The MSME/start-ups find it difficult to hire top talent and retain them. It is important to incentivize the top talent to work in R&D oriented deep tech start-ups/MSMEs

### 7. Do not Penalize genuine efforts:

One of the features of many programs is extreme penalties in case of failure. Fear of failure is the single most reason why people don't try new things. Especially when the target is long term and markets are uncertain, the fear factor is already high. While checks and balances are needed to make sure proper usage of the funds, GoI should not penalize genuine failures (especially for not being able to perform things that companies don't have direct control, like market success).

## 15. Specific steps: How to get back on track

1. Call Indian chips Indian:

a. Correct the PLI, Preferred Market Access polices across the board to reflect that Chips owned by Indian Fabless companies as Local Content, irrespective of where they are manufactured.

b. Public Procurement Notification has no additional weightage for using chips designed in India in local content calculation. Provide additional weightage for chips owned by Indian companies.

c. Promote Indian core technology, example: additional weightage for using IRNSS where any GNSS is required.

d. Recognize chips owned by Indian Fables Companies as "Made in India". Policy changes to recognize the chips sold by such companies to customers in other countries as exports (even though fabricated in other parts of the world).

2. Clear the existing hurdles for operating across trusted nations:

a. Ease the duties and complex mechanisms of import/export of wafers/dice/packaged chips/test boards by Fabless Indian Companies

b. A detailed description of the problem and some suggestions are presented in Annex A

3. Treat Private R&D equal to academic R&D

a. Trust the private companies

b. ROI will be realized through rupee saved in import substitution and increased exports

c. Extremely deep R&D needs some serious backing.

d. A mechanism to include bona-fide in-house R&D in Indian start-ups, MSMEs into the R&D support schemes that are available to academia are presented in Annex B.

4. Identify different kinds of chips of national interest and support their development in the appropriate manner

A. CHIPS FOR CRITICAL/STRATEGIC INFRASTRUCTURE

a. Networks for National Security, defence

b. Networks for internal security, law and order

c. National Telecom Network on which Govt. Machinery runs

d. Networks for hazard/health/disaster management

e. These are the chips that are necessary for the country to have in its ownership. Government (Defence, DPSU, PSU) would be a customer for these chips.

e.i. Chips that are used in defense equipment

e.ii. Chips that carry Govt and strategic data

e.iii. Chips whose non-availability can cause a serious loss to the country

f. If a chip needed for these is present in India, make it mandatory that it is used in developing systems for these purposes

g. If such a chip is not present in the hands of an Indian company, call for Indian companies to develop the chips for these and supply to Govt/DPSU (insist on IP level ownership in India). Chip Design challenge is a good way to get this going (detailed in Annex C)

h. This activity itself will allow some companies to find some footing.

i. Many large corporations in the world today started off their journey this way

B. GENERIC REPLACEMENT CHIPS

a. Generic chips (like discrete, ADCs, DACs, amplifiers etc.) present in existing systems made by DPSUs/PSUs

b. Can be replaced by Indian Chips to increase local content

c. Fund the development of some generic replacement chips for systems on which we need complete ownership. Such chips might not have useful commercial value outside the strategic need. But will again help the Companies find footing and larger number of small ideas can be accommodated from many companies, paving way for an ecosystem.

C. COMMERCIAL CHIPS FOR UBIQUITOUS QUINTESSENTIAL USAGE BY COMMON MAN

a. Commodity Voice, Data, Video

b. Help MSME to break the backlog barriers by incentivizing private R&D on commercial chips

(i.e chips that are not necessarily strategic)

b.i. Provide Grants to cover third party expenses like tape out, EDA tool licenses, Test equipment and Automated test equipment

b.ii. Reimburse 50% R&D expense

b.iii. Both on the condition that the company is Indian and any acquisition by

foreign entity would require repayment of the assistance and/or a license to use the R&D within India, commensurate to the incentive received by the MSME

c. Provide a subsidy for first 1 million chips of any kind sold by an Indian company. This will help in breaking the commoditization issue.

d. Mandate usage of chips owned by Fabless Indian companies in systems claiming Make in India benefits.

D. COMMERCIAL FUTURISTIC CHIPS OF HIGH PERCEIVED VALUE

a. Like AI, ML, High Performance Computing, Data Center…
b. VCs will be interested in these ideas
c. Facilitate initial seed funds, Prototypes
d. Ensure Indian companies remain Indian

5. Help Indian chip companies to build their labs

a. Provide customs waiver for lab equipment import by start-ups/MSMEs
b. The labs to test these chips need a lot of high-end equipment. There is a large availability of used high end equipment in the world. However, the import of such equipment requires special permissions and is long a drawn process due to fear of e-waste dumping. This puts a burden on the already cash starved start-ups/MSMEs to resort to buying brand-new equipment at significantly higher costs.
c. Enable import of used lab equipment by Fabless start-ups/MSMEs. A check can be implemented saying that the cost of such import shall be more than Rs 1000 per kg, which will avoid e-waste dumping.

6. Build the advanced test ecosystem: These are the tasks that are used sporadically by companies. Currently many of these require going out of the country. Common facilities for such activities will significantly help

a. Failure analysis lab
b. Telecom test lab (protocol testers etc.) given free of cost to MSME for indigenous products testing. Charged to bigger/services companies.
c. Field test and interop lab

7. Identify/Tie up with “trusted fabs”
   Identify a list of trusted fabrication houses and ensure that the chips being built with incentives above are fabricated in those fabs.

8. Come up with a scheme like STPI to encourage top talent to work in deep tech start-ups and MSMEs. One suggestion is to provide income tax holiday for employees of Indian start- ups/MSMEs working on core deep technology development for one window of 10 years in their life cycle. This will help Indian MSMEs to hire the best talent with a direct mark up of 30% on salaries of top talent in the country. Once the objective is achieved, this scheme can be sunset.

## 16. CONDITIONAL ROYALTY MODEL :

The model suggested is that Govt funds the R&D for the chip challenge winners up to a stipulated amount and upto 50% of R&D expenditure which enables the company to take the risk and spend its own time/money to make the chips. Some of this can be upfront, some as R&D expense reimbursement. One avenue could be to fund VLSI/Chip development under TRDF. TRDF funding is generally as soft loans or grants in exceptional cases. As mentioned earlier, the break-even point for chip companies is very long term. A company would take loans if they were confident of returning the money soon enough. While soft

loans are a help, Fabless will need grants. For the reasons given above, we suggest that Fabless VLSI/Chip development should be considered exceptional case and given funding as Conditional Grants.

There would be periodic reviews of the technical progress and funding can be milestone based further funding can be only to programs that show serious commitment. The model in brief:

a. Govt helps the fabless industry take the risk by funding through grants
b. Govt asks back the money when the company has it

Once the chips are in sales phase, the companies provide the Govt with a royalty. The royalty will stop once the Govt recovers the money.

### 17. What happens if no sales happen?

In case of tech performance failure, the grants would have stopped in early stage without much loss to the Govt.. Only companies that have shown tech performance would have gotten all the funding. If a technically competent product does not get market success, even the company that co-invested loses its investment. That is the risk GoI should be ready to take to develop this industry. Even in this case, Govt wins since we would definitely have become Atmanirbhar.

### 18. Can Fake companies not game this?

50% borne by the company is still a huge amount in the chip design world. It is very unlikely that a company would invest hundreds of crores to just game the system. Nevertheless, checks and balances have to be established to curb misuse of the scheme.

19.

20.

## 21. Annex A : Removing hurdles faced by Indian Semiconductor Companies in manufacturing/packaging of Semiconductor Chips and bringing them into India

Fabless Semiconductor companies are envisaged to form a very important part of Atmanirbhar Bharat. For the manufacture of ICs, Indian fabless companies are dependent on semiconductor fabricators (fab), who are present outside India. As part of the fabrication (manufacturing) process, the fab creates mask set specific to the particular IC. This mask set is used further to produce the actual semiconductor wafers. Semiconductor chips are created using these wafers and further they need to be packaged[1] before being sent to the Fabless Company or to its customers (who may be in India or elsewhere in the World).

While the wafer is created in a fab in one foreign country, the wafer further needs to be sent from one foreign country to another based on the availability of vendors for package encapsulation. During the package encapsulation, original wafers will be cut into hundreds/thousands of ICs and each is encapsulated with the packaging material which is separately prepared. Wafer and/or chip level testing of each chip will be done using Automated Test Equipment (ATE).

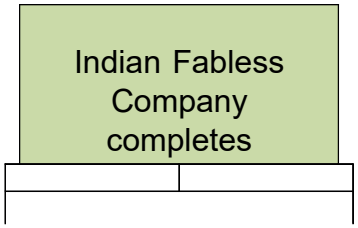
As the encapsulation involves multiple foreign vendors in different countries often there will be 2 to 3 remittances to different vendors and involves more than one Invoice. The remittances can be one-time or upfront and per wafer/chip/package cost. Final goods come in different quantities than the quantity mentioned in the first vendor's Invoice. This creates issues with the Customs clearance as Customs want the quantities to be matched with every Invoice remitted and product physically identified. But the product can be identified only with the last processing invoice. Also, physically opening wafers and half processed chips will render them unusable.

As can be seen, while the Fabless Semiconductor Company owns the design and Chip itself, the process of manufacturing it goes through multiple material procurements in more than one country. There are multiple foreign remittances needed to facilitate these activities and many compliance steps need to be followed. In some cases, the guidelines are confusing and subjective. A simple courier task becomes a massive compliance exercise every time a company must make even a test chip. There is a need to simplify the process and facilitate the smooth operation of semiconductor companies in India

[1] Semiconductor Packaging is a specific manufacturing process and should not be confused with the general term "packing" which done for any product. Semiconductor packaging involves putting together the bare wafer dice with additional material, circuitry components, substrates, lead frames, pins and mechanical stabilizers to create the final form in which a chip is brought out to market. Such "packaged" chips will be then "packed" in different forms like trays, tapes, reels etc. and sealed in electrostatic discharge safe pouches and shipped.

The following figure shows the steps that fabless companies go through to manufacture either test chips or production chips.

The following flow chart describes the same in terms of the financial, invoicing/billing/filing procedures that an Indian fabless company has to follow to manufacture either test chips or production chips. The green boxes show the flow chart and the red boxes show the compliance issues they face in particular steps.



Given lacuna in the indigenous ownership of semiconductor all this contributes to loss of money, manpower and precious time delaying progress of the country in the larger sense.

Here are some suggestions to facilitate Fabless Semiconductor Industry

b.1. Automatic Bill of Entry Waiver for remittances made to fabs in trusted countries for the purpose of mask-sets

b.2. Single Bill of Entry for package and wafer invoices when packaged chips arrive at the ports

b.3. Facilitate green channel customs clearance for bonafide Fabless semiconductor companies. Avoid physical opening of delicate semiconductor material at customs ports.

b.4. Allow Indian fabless companies to move their test equipment/PCBs at the location of testing/mass manufacturing for the duration of manufacturing without double/triple payment of customs/duties.

b.5. Recognize chips owned by Indian Fables Companies as “Made in India”. Policy changes to recognize the chips sold by such companies to customers in other countries as exports.

## Annex B: R&D Grants for Fabless Telecom Chip Companies with safeguards ensuring that the IPR ownership remains within India

### 1. Introduction

This document briefly outlines key policy suggestions to provide support to indigenous semiconductor industry. Semiconductor's chipset are the heart and soul of technology, they define what technology products and solutions can or cannot do. Globally the semiconductor industry is dominated by large MNCs from a handful of countries, but there is a nascent indigenous industry which is doing its best to establish a foothold in this market. A little bit of policy support can go a long way in ensuring that we have a sustainable indigenous capability in this crucial domain.

The criteria outlined below were used to ensure the interests of all stake holders involved from the Government of India to public and private sector companies.

- Clear and objective criteria to qualify for support
- Well defined obligations for all stake holders, including safeguards
- Well defined outcome promoting indigenous capability

The support suggestions directly address the following main barriers

- High cost of Electronic Design Automation (EDA) tool licenses
- High cost of fabrication of the chipset in foundries (tape-out)
- High cost of productization of the chipset post silicon (ATE and Production Test development)
- High cost and limited availability of skilled labor and know-how involved in designing semiconductor IPs

Due to the nascent state of the industry and risks involved, the large initial investments required are difficult to commercially justify. One avenue could be to fund VLSI/Chip development under TRDF. TRDF funding is generally as soft loans or grants in exceptional cases. As mentioned earlier, the break- even point for chip companies is very long term. A company would take loans if they are confident of returning the money soon enough. While soft loans are definitely a help, Fabless will need grants. For the reasons given above, we suggest that VLSI/Chip development should be considered exceptional and given funding as Conditional Grants. The Grant amount may be recovered after the initial support phase through royalties on sales.

### 2. Support for EDA tool license

| | |
|---|---|
| Qualification criteria | 1) EDA tool licenses taken to develop and tape-out semiconductor ICs and<br>2) Taped-out semiconductor ICs fully owned by Indian MSME, i.e. revenue from sale of the ICs will accrue to entity registered as company in India |
| Nature of support | 50% of cost of EDA tool licenses purchased, supported by invoices |
| Safeguards | Support amount paid out upon utilization for development of indigenous chips<br>Service companies need to maintain the R&D related expenses separately (ensured by the approved R&D center requirement above) |
| Outcome | Creation of indigenously owned semiconductor ICs in the ICT domain Control over the core security and services of defense, strategic services and ICT enabled economy<br>Reduction of imports, promotion of value-added exports |

### 3. Support for chipset fabrication

| | |
|---|---|
| Qualification criteria | 1) Tape-out of semiconductor ICs fully owned by Indian MSME, i.e. revenue from sale of the ICs will accrue to entity registered as company in India<br>2) The development of the IC happens inside an R&D center approved by DSIR |
| Nature of support | 50% of cost of tape-out, supported by invoices as R&D grant |
| Safeguards | Support amount paid out upon successful completion of tape-out |
| Outcome | Creation of indigenously owned semiconductor ICs in the ICT domain. Control over the core security and services of defense, strategic services and ICT enabled economy<br>Reduction of imports, promotion of value-added exports |

### 4. Support for ATE and Production Test Development

| | |
|---|---|
| Qualification criteria | 1) Tape-out of semiconductor ICs fully owned by Indian MSME, i.e. revenue from sale of the ICs will accrue to entity registered as company in India<br>2) The development of the IC happens inside an R&D center approved by DSIR |
| Nature of support | 50% of cost of ATE development, PCBs, test floor expenses for R&D, supported by invoices as R&D |
| Safeguards | Support amount paid out upon successful completion of ATE |
| Outcome | Enables the Indian Telecom Chips to move to mass production Reduction of imports, promotion of value-added exports |

### 5. Support for semiconductor IP creation

| | |
|---|---|
| | 2) The development of the IC happens inside an R&D center approved by DSIR |
| Nature of support | R&D grants upto 50% of the expenses towards development and testing of core IP in the ICT domain. |
| Safe guards | If the IP ceases to be fully owned by Indian company, a non-exclusive license of the IP created will be automatically awarded to GoI/designated PSU.<br><br>Nature of the license granted<br>A. Architecture license: if the grant is >= 50% of the market value of the architecture license of same IP<br>B. Multiple use source: if the grant is >= 50% of the market value of the multiple use source license of same IP<br>C. Multiple use hard/encrypted IP license: if the grant is >= 50% of the market value of the multiple use hard/encrypted license of same IP<br>D. Single use source: if the grant is >= 50% of the market value of the single use source license of same IP<br>E. Single use hard/encrypted IP license: if the grant is >= 50% of the market value of the single use hard/encrypted license of same IP<br><br>Market value to be determined by a committee of representatives from the industry and GoI/PSU/Academia/Market Research |
| Outcome | Creation of library of indigenously owned semiconductor IPs leading to a multitude of indigenous chips in the longer run |

## 22. Annex C: Telecom Chip Design Challenge

As outlined earlier in this document, there are certain chips that are critical for the strategic telecom networks in the country. Today, telecom equipment makers find it difficult to make systems with core Indian content since there aren't many Indian chips for their data paths. While there are a few Indian Chip design companies with capability and chips to address some of the requirements, they need market visibility and funding support to hasten their development of 5G RAN chips. A chip design grant challenge would serve both the purposes very effectively.

The suggestion here is to identify three-four specific chips that are relevant today and throw open a grant challenge to the existing companies in the country to develop them. The advent of 5G provides an excellent opportunity to do this. 1-2 companies can be selected to develop each chip using grants.
The grants can be for chips targeting

a. 5G Radio Unit
b. 5G Distributed Unit and Central Unit
c. Small Cells
d. NBIoT
e. SDR
f. Power Amplifiers
g. UE, i.e. mobiles

A fair selection procedure can be used to pick 1-2 companies to execute each of the chosen chips. At the end of this effort, we will have a healthy set of chips that can fuel the RAN equipment in India and elsewhere. With this, a truly Atmanirbhar 5G can be created in a 2-3 year horizon.

Checks and balances mentioned in Annex B can be brought into the scope to ensure that Indian IPR remains Indian and the benefits go to Indian companies.