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5G Evolution and 6G:
Private Network for Educational Institutions, Government Enterprise

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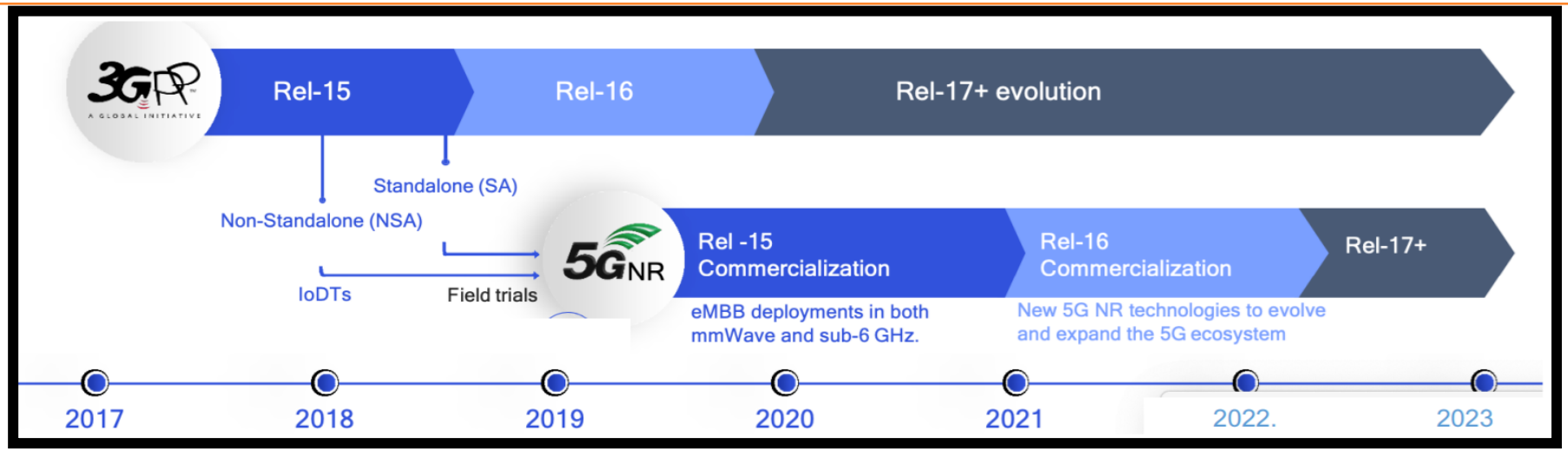
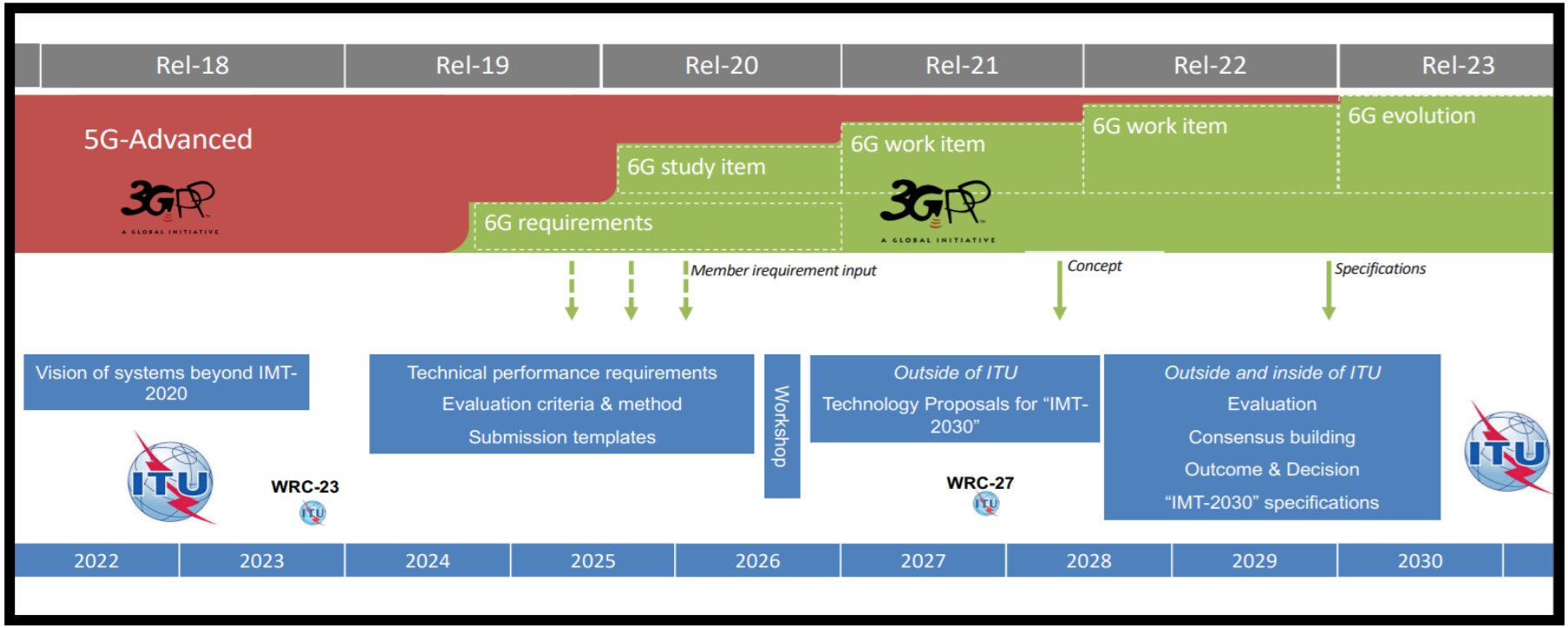
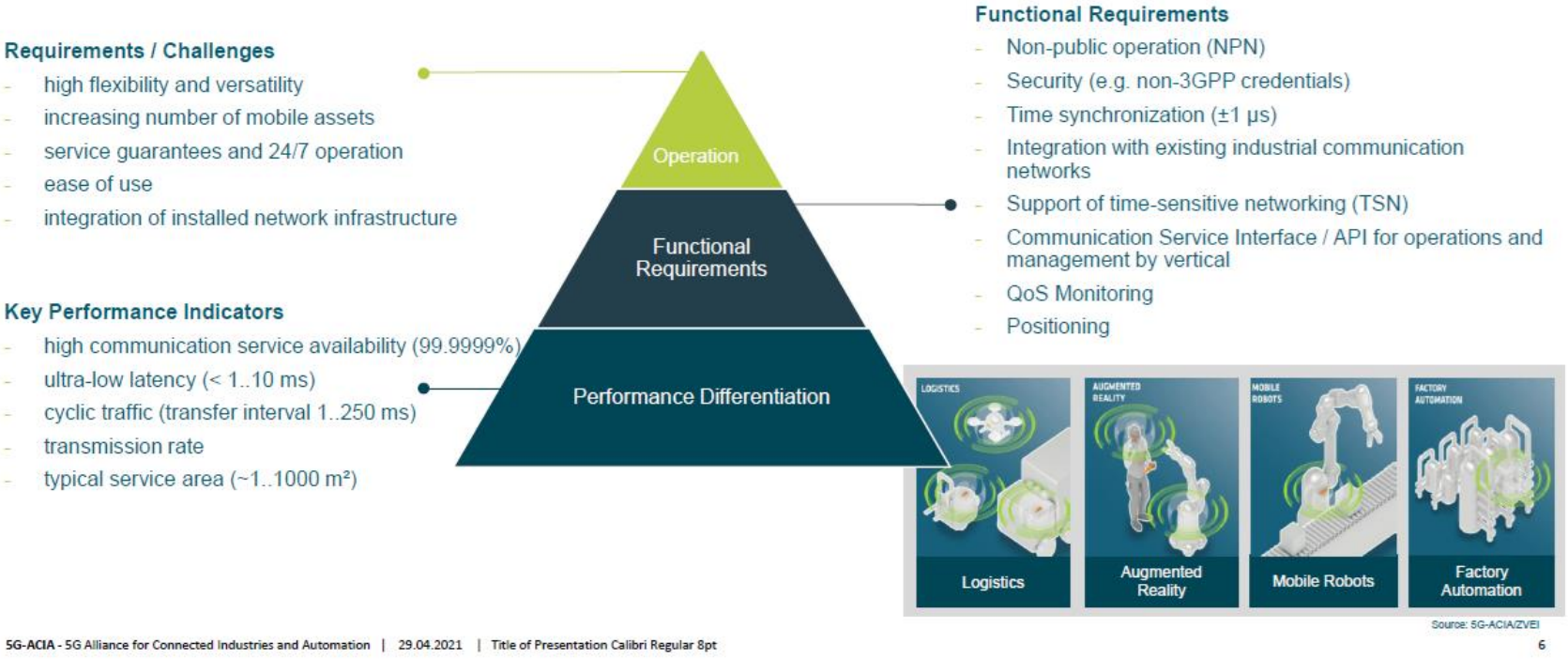
5G / 5G Advanced / 6G Standardization Timelines



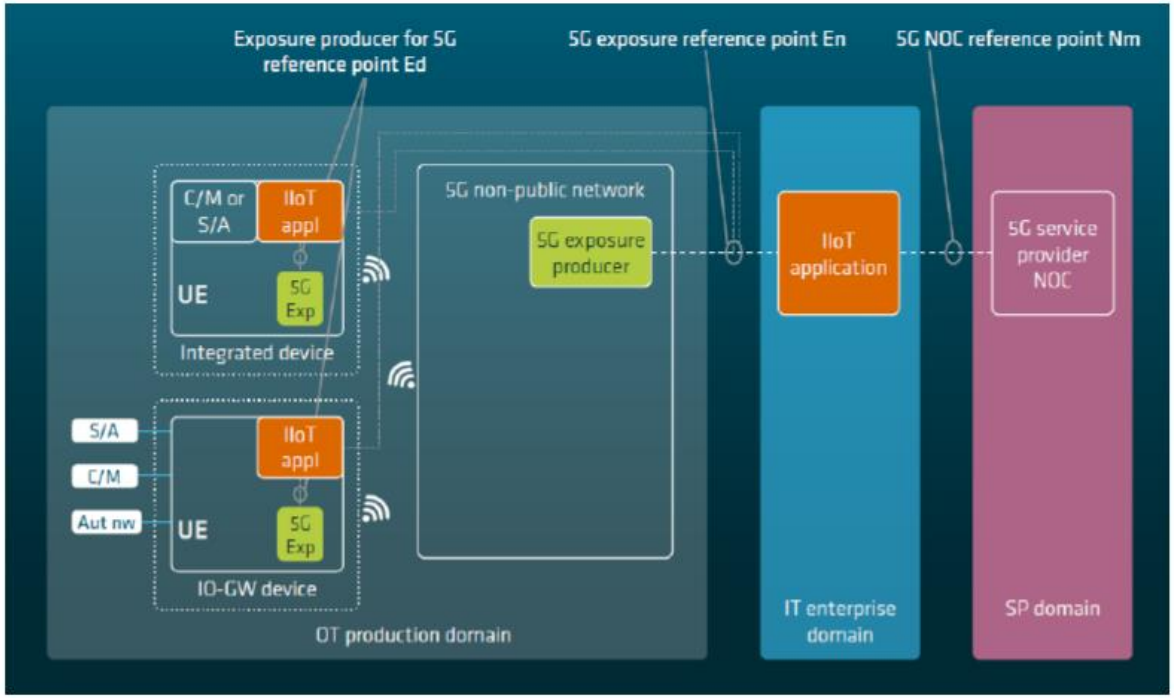


Multi-dimensional Industrial 5G Requirements



- The 5G industry is rapidly evolving, and 3GPP's 5G Release 18 standard is set to revolutionize the space with 5G Advanced.

5G Capabilities Exposure Interface



- **Device management**
  - Device identity management
  - Device provisioning and onboarding
  - Device connectivity management
  - Device connectivity monitoring
  - Device group management
  - Device location information
- **Network management**
  - Network monitoring
  - Network configuration and maintenance

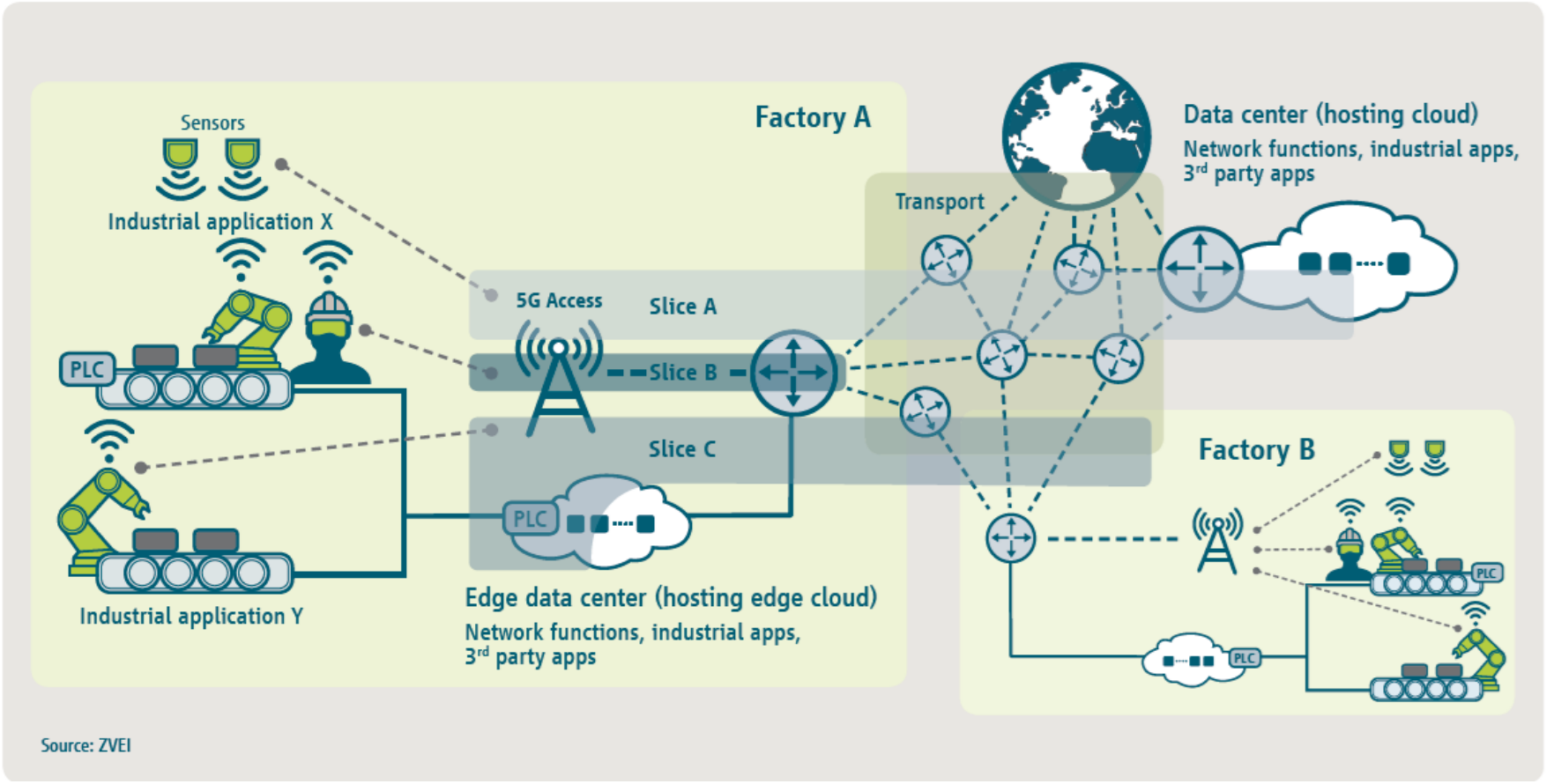
Technologies critical for the Industry 4.0 transformation

Vertical stakeholders of 5G-PPP projects regarded the following technologies as either Significant or Critical to I4.0 realization:

- Mobile robotics , Edge computing, Machine learning, IoT, IIoT (Industrial IoT), Hybrid cloud, Computer vision , and 3D Printing (**above 66% of responses**).
- WiFi, AR/VR/XR, 5G URLLC, 5G mMTC, 5G eMBB, TSN (Time Sensitive Networking) and DETNET (Deterministic Networking) Standards, Network Slicing, and Blockchain (**33% to 66% of responses**).
- Network Exposure, Tactile Internet, Public Cloud, and Quantum Computing **(up to 33% of responses**).

Network Slicing : Industrial Applications

- Network slicing could also extend beyond a single plant, as it allows cross-plant communication on a global scale.

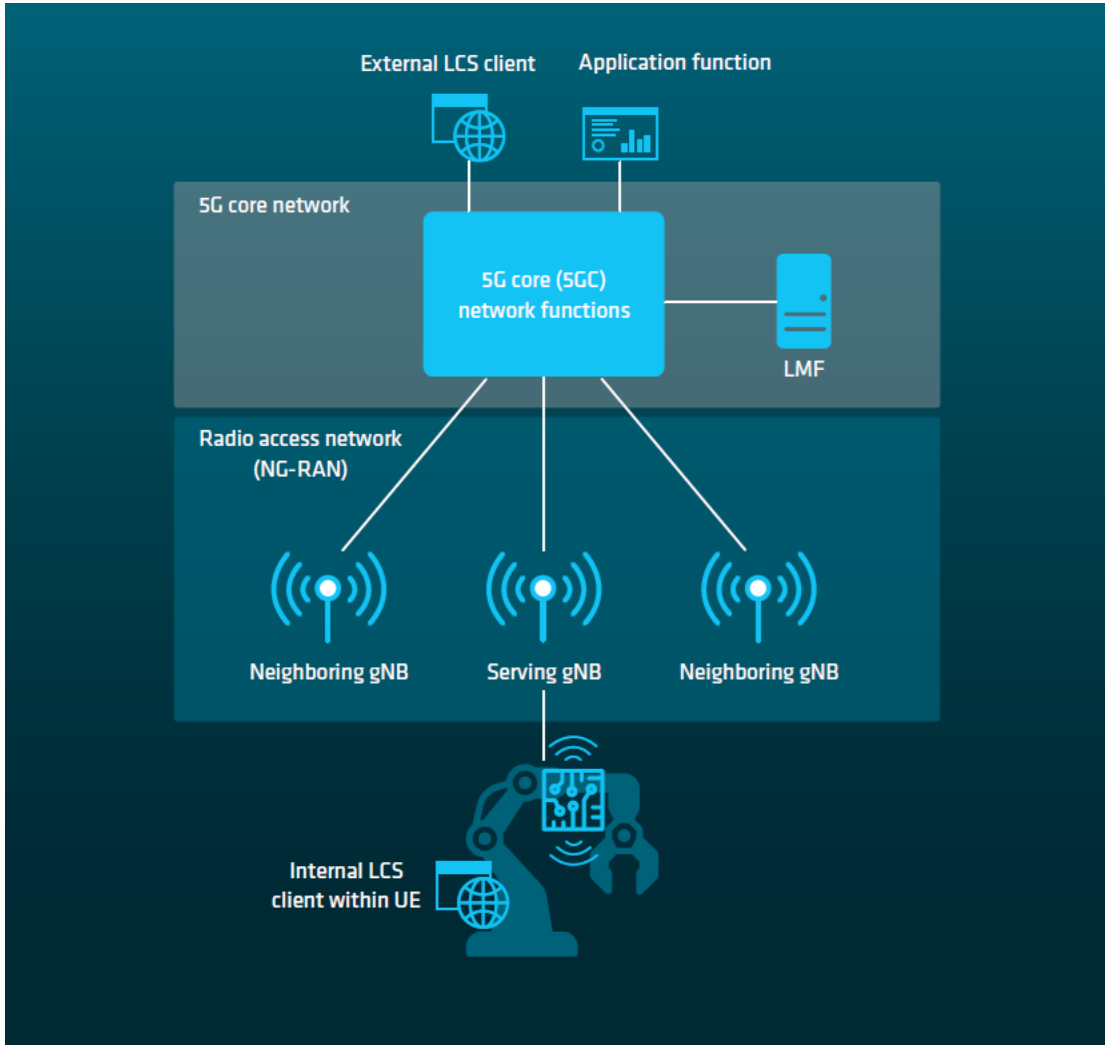


Time-sensitive networking (TSN)

- Time-sensitive networking (TSN) ensure deterministic, reliable, high-bandwidth, low-latency communication.
- TSN was introduced in 5G Release 16 and extended in Release 17.
- IEEE 802.1Qcc has been adopted for 5G-TSN integration.
- The 5G system uses one or more virtual or logical TSN-capable bridge(s) of the TSN network to interact with the TSN network on the control or user plane.
- TSN-capable bridge is also referred to as a 5G system bridge. It includes TSN translator (TT) functionality for interacting with the TSN network. TSN translator functionality is available:
  - on the control plane via a TSN application function (TSN AF),
  - on the UE side via a device-side TT (DS-TT), and
  - on the user plane function (UPF) side via a network-side TT (NW-TT).

Three Dimensional Positioning in Industrial sectors.

- Important requirements in many industrial sectors.
- Positioning required for
  - tracking personnel and assets,
  - Safety,
  - locating tools in manufacturing and assembly facilities,
  - optimizing supply chains,
  - controlling automatic guided vehicles.



5G in Educational Institutions

1. **5G technologies** : Competencies and engagement.
2. **5G projects :** under-graduation and post-graduation.
3. **5G use cases** : academia-industry engagement.
4. **Startups and MSMEs** : Local access of 5G test setup.
5. **6G ready** : Indian academia & startup ecosystem

Institution deliverables

1) **Utilisation of the lab :** Testing/Project development per year.

   - 50 no. of Students and 10 nos. faculty.
   - 5 nos. of Start-ups/MSMEs.

2) **Products/solutions/IPs developed/tested :** 10 per year

3) **Contribution to standardization process :** and drive the technologies developed/being developed to become part of the standards.

4) **Papers to be published :** 02 per year

5) **Pilot/Commercialise/Deploy :** Tested/developed products in field.

5G Private Network for Mines

TCIL is establising CoE with an objective to achieve the following subsequently.

- Traffic control (5G AI based camera)

- Vehicle Monitoring (Dumper and shovel)
  - Dynamic allocation of dumper loading system.
  - Monitoring of payload system, engine temperature, tire pressure, and fuel level.

- Anti-collision system for dumpers to enhance safety and efficiency in mining
  - Combination of sensors, cameras, and real-time data processing to detect obstacles or potential collisions in the dumper's path.

- Monitoring of mine site, stockpiles, spreading of seeds (plantation), and blasting area (5G drone)

5G Private Network : Copper Concentrate Plant Process Automation

1. Monitoring Ore Crusher Dumping Pit
2. Conveyor Belt :
   - Bolder size detection, Rock bolting rod detection, HDPE pipe detection, other unwanted materials such as cotton waste etc.
   - Ore level and volume detection.
3. Ball Mill Operation: Stream density meter/analyser in ball mill to find out the density of slurry.
4. Froth Flotation Process: Froth level detection, froth bubble size detection, froth bursting time detection in flotation cells.
5. Predict and prevent faults and breakdowns to reduce down time and improve life of the machine.
6. Copper Concentrate Loading Management
7. Online water monitoring system in Environmental Ponds : PTZ camera data transfer to MP Pollution control Board

Indigenous 5G Network Functions availability for Enterprise Network ?

1. Network Exposure Function (NEF)
2. Network Repository Function (NRF)
3. Network Slice Selection Function (NSSF).
4. Network Slice Specific Authentication and Authorization Function (NSSAAF).
5. Trusted Non-3GPP Gateway Function (TNGF).
6. Network Data Analytics Function (NWDAF).
7. Wireline Access Gateway Function (W-AGF).
8. Trusted WLAN Interworking Function (TWIF)
9. Non-3GPP Inter Working Function (N3IWF).
10. 5G LAN-Type Service
11. Ethernet Transport Services
12. Low Latency and High Reliability
13. Positioning services
14. Time sensitive communication as defined in IEEE 802.1

TCIL role in Building 5G Private Network

- TCIL shall undertake all activities from conceptualization of 5G NPN to monitoring of SLA of the Services and Network.

- Scope of Consultancy is categorised into following 4 phases:

  - Current State Assessment & Best Practices Study.
  - Solution Design & Equipment/OEM Selection.
  - Project Management & Change Management support.
  - SLA Monitoring

- Proof of Concept as per the requirement of 5G NPN Solutions.

Thank You