Received: 32 January 2022

Source: Annex 3.3 to Document 5D/886

Document 5D/992-E
1 February 2022
English only

GENERAL ASPECTS

ITU-APT Foundation of India (IAFI)

FURTHER UPDATES TO WORKING DOCUMENT TOWARDS A PRELIMINARY DRAFT NEW REPORT ITU-R M.[IMT.INDUSTRY]

Applications of IMT for [Specific] Industrial and Enterprise Usages

1 Introduction

In its 39th meeting, Working Party (WP) 5D continued further work on a draft new Report ITU-R M.[IMT.INDUSTRY] Applications of IMT for specific industrial and enterprise usages. This work was initiated in WP 5D in response to Question ITU-R 262/5 which calls upon ITU-R to study specific industrial and enterprise applications, their emerging usages, and their functionalities, that may be supported by IMT.

It is worth noting that WP 5D had earlier developed and published Report ITU-R M.2441 in 2018. That report provided an initial compilation of usage of IMT in specific applications.

2 Proposal

IAFI is proposing further edits to Section 9 of the working document. Additionally, IAFI also proposes inclusion of an Annex for mmWave in Manufacturing in Annex X.1.

Attachment: Updated working document

ATTACHMENT

WORKING DOCUMENT TOWARDS A PRELIMINARY DRAFT
NEW REPORT ITU-R M.[IMT.INDUSTRY]

Applications of IMT for specific societal, industrial and enterprise usages

(Question ITU-R 262/5)

TABLE OF CONTENTS

[Editor's note: The terminology to be used in this document including private vs. local vs. enterprise networks such as non-conventional use, etc. needs to be clarified]

1 Scope

This report addresses the usage, technical and operational aspects and capabilities of IMT for meeting specific needs of societal, industrial and enterprise usages.

2 Introduction

Report ITU-R M.2441, published in 2018, provided an initial compilation of usage of IMT in specific applications. Further, it introduces potential new emerging applications of IMT in areas beyond traditional voice, data and entertainment type communications as envisaged in the vision for IMT-2020. PPDR, one of the specific applications of IMT is addressed in Report ITU-R M.2291.

This report has been developed in response to Question ITU-R 262/5 which calls upon ITU-R to study specific industrial and enterprise applications, their emerging usages, and their functionalities, that may be supported by IMT.

Today's industrial automation is powered by ICT technology and this trend will increase manifold with advent of new broadband mobile technologies such as IMT-2020, leading to increased business efficiencies, improved safety, and enhanced market agility. Industry 4.0 enables industries to fuse physical with digital processes by connecting all sensors and actuators, machines and workers in the most flexible way available. Tethering them to a wired network infrastructure is expensive and, ultimately, it will limit the possible applications of Industry 4.0. Industrial grade private wireless will unleash its real potential by providing the most flexible and cost-effective way to implement a wide range of Industry 4.0 applications. Current IT based automation solutions are well adapted for day-to-day business communications but are limited in reliability, security, predictable performance, multiuser capacity and mobility, all features which are required for operational applications that are business or mission critical. Similarly, applications in mines, port terminals or airports require large coverage area, low latency and challenging environments, which so far only two-way mission critical radios could meet. In both mining and port terminals, remotely operated, autonomous vehicles, such as trucks, cranes and straddle carriers are used requiring highly reliable mission critical mobile communications.

Taking manufacturing, with thousands of factories with more than 100 employees, as an example, typical business cases revolve around controlling the production process, improving material management, improving safety, and introducing new tools. Research has shown that manufacturers can expect to see a tenfold increase in their returns on investment (ROIs) with IMT-2020, while warehouse owners can expect a staggering fourteenfold increase in ROI. Fortunately, IMT-2020 is available in configurations perfectly suited to building industrial-strength private wireless networks to support Industry 4.0. They bring the best features of wireless and cable connectivity and have proven their capabilities both in large consumer mobile networks area as well as in many industrial segments. The time is ripe for many industries to leverage private and captive IMT-2020 to increase efficiencies and automation. In simple terms –

(i) A private network is a dedicated network of the enterprise involving connections of the people, systems and processes of the enterprise.

(ii) A private network is a dedicated network by the enterprise setup internally in the enterprise by internal IT teams or outsourced.

(iii) A private network is a dedicated network for the enterprise to enable communication infrastructure for the systems and people associated with the enterprise.

The emergence of ultrafast IMT-2020 technology in higher (mmWave) frequency bands as well provides manufacturers with the much-needed reliable connectivity solutions, enabling critical communications for wireless control of machines and manufacturing robots, and this will unlock the full potential of Industry 4.0.

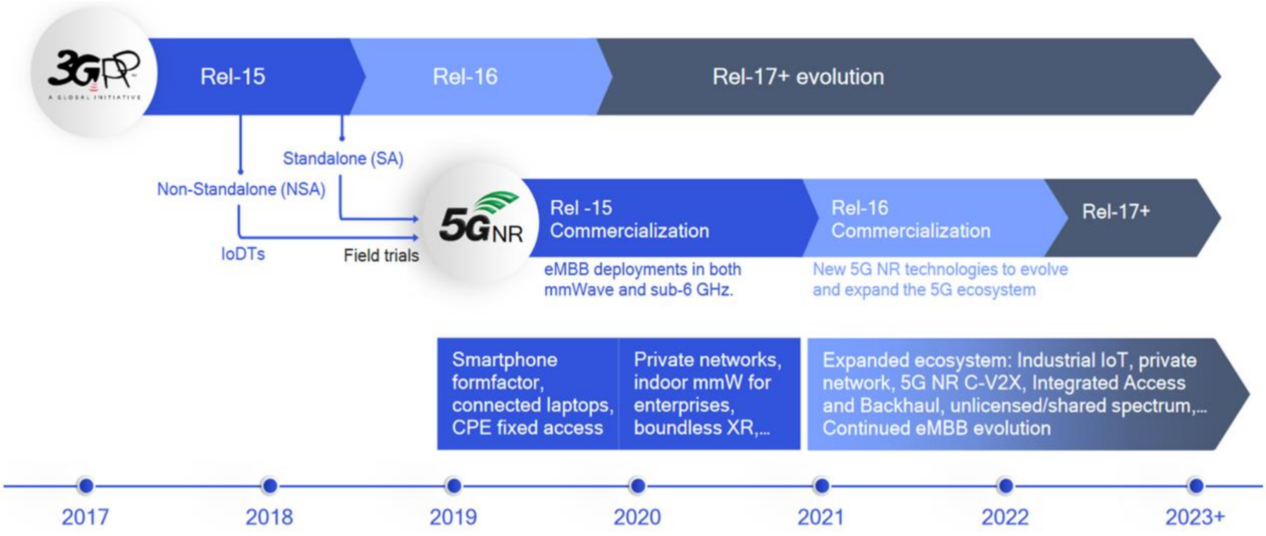
Apart from manufacturing, many other industries are also looking at IMT-2020 as the backbone for their equivalent of the Fourth Industrial Revolution. The opportunity to address industrial connectivity needs of a range of industries include diverse segments with diverse needs, such as those in the mining, port, energy and utilities, automotive and transport, public safety, media and entertainment, healthcare, agriculture and education industries, among others.

Some recent trial of IMT in port operations demonstrated the “New Radio” capabilities for critical communications enablers such as ultra-reliable low-latency communication (URLLC), enhanced mobile broadband (eMBB) to support traffic control, AR/VR headsets and IoT sensors mounted on mobile barges and provides countless possibilities to improve efficiency and sustainability in seaports and other complex and changing industrial environments. In response to the impact of COVID-19 pandemic some ports are increasing/accelerating their adoption of digital processes, automation and other technologies to enhance efficiency and resiliency to crises such as a global pandemic.

Similarly, in mining exploration sites, the drilling productivity could be substantially increased through automation of its drills alone. Additional savings from increased usage of equipment could also lead to lower capital expenditures for mines (CapEx) as well as a better safety and working environments for their personnel.

FIGURE 1

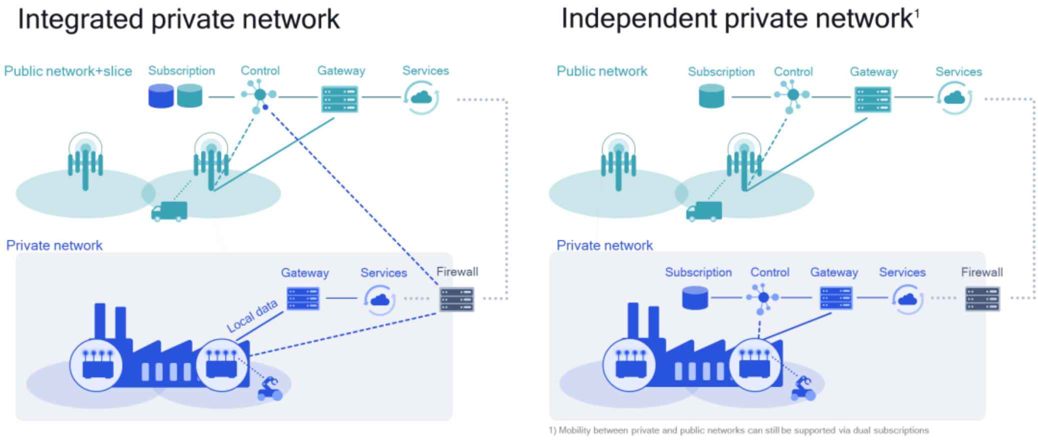
IMT Technology Evolution



Even the most advanced factories of today still largely depend on inexpensive unlicensed wireless networks that have several drawbacks, such as lack of protection and potential interference in dense settings and complex fixed connections that are difficult to manage in large industrial settings. While the unlicensed spectrum is freely available, it is severely limited in quality of service (QoS) and support for mobility. In smart manufacturing, such networks cannot support the mobile requirements of automated guided vehicles (AGVs) or the even some of the faster moving arms of robots. It also does not support low power requirements of sensors and other IoT devices. Further, it cannot support the high density of sensors, devices, robots, workers and vehicles that are operating in a typical manufacturing plant.

FIGURE 2

Examples of private network architectures
[in relation to public networks] [depending on regulatory aspects and deployments needs]



An example of an application in health care that need critical communications that is supported by new capabilities of IMT is remote robotic surgery. A latency of 1 millisecond is critical in providing haptic feedback to a surgeon that is connected through a mobile connection to a surgical robot. A high data rate is needed to transfer high-definition image streams. As an ongoing surgery cannot be interrupted an ultra-reliable communication is needed to keep connection down-time and packet loss very low.

A new generation of private IMT networks is emerging to address critical wireless communication requirements in public safety, manufacturing industries, and critical infrastructure. These private IMT networks are physical or virtual cellular systems that have been deployed for private use by a government, company or group of companies. A number of administrations took the lead to enable locally licensed or geographically shared IMT spectrum available for enterprise use and have begun to recognize spectrum sharing and localised broadband networks in providing flexibility and meeting the needs of critical communications by vertical industries and enterprises. Some administrations have decided to partition the IMT spectrum between commercial carriers and private broadband and others enabled opportunistic use and dynamic access to IMT spectrum that is licensed to commercial carriers.

3 Related ITU-R documents

[1] Question ITU-R 262/5 – Usage of the terrestrial component of IMT systems for specific applications. (Copy reproduced in Attachment 2).

[2] Recommendation ITU-R M.2083 – Framework and overall objectives of the future development of IMT for 2020 and beyond.

[3] Report ITU-R M.2440 – The use of the terrestrial component of International Mobile Telecommunications (IMT) for Narrowband and Broadband Machine-Type Communications.

[4] Report ITU-R M.2441 – Emerging usage of the terrestrial component of International Mobile Telecommunication (IMT).

[5] Report ITU-R SM.2404 – Regulatory tools to support enhanced shared use of the spectrum.

[6] Report ITU-R SM.2405 – Spectrum management principles, challenges and issues related to dynamic access to frequency bands by means of radio systems employing cognitive capabilities.

4 Acronyms and definitions

[TBD]

5 Industrial and enterprise usages and applications supported by IMT

[Editor's Note: LS to 3GPP TSG and other external organizations needs to be sent to get information for this section.]

5.1 IMT applications in mining sector

5.2 IMT applications in oil and gas sector

5.3 IMT applications in distribution and logistics

5.4 IMT applications in construction and similar usages

5.5 IMT applications in enterprises and retail sector

5.6 IMT applications in healthcare

5.7 IMT applications in utilities

5.8 IMT applications community and education sector

5.9 IMT applications in manufacturing

5.10 IMT applications in airports and ports

5.11 IMT applications in the agriculture sector

6 Required capabilities of Industrial and Enterprise usages supported by IMT

[Editor notes: This section includes categories of applications/usages and corresponding requirements supported by IMT. This may also include low-band, mid-band and high-band requirements to support the different use-cases identified in Section 5.]

7 Technical and operational aspect of industrial and enterprise usages supported by IMT

8 Case studies

Annex I Case study of IMT applications in airports/ ports/ logistics

Annex II Case study of IMT applications in mining sector

Annex III Case study of IMT applications in oil and gas sector

Annex IV Case study of IMT applications in distribution and logistics

Annex V Case study of IMT applications in construction and similar usages

Annex VI Case study of IMT applications in enterprises and retail sector

Annex VII Case study of IMT applications in healthcare

[9 Spectrum access and implementation aspects]

[Editor's note: Frequency bands, if any, can be added later from contributions]

Mobile cellular network technology is generally deployed and operated by licensed mobile network operators (MNOs). Private networks are a big change to this construct and their implementation can vary depending on which party should design, deploy, operate, and own them.

In terms of physical deployment, the term "private network" refers to networks with radio, core, and transmission resources dedicated to the enterprise and – crucially – under the control of the enterprise. This generally means network equipment will be deployed on the customer premises, regardless of which party manages it day-to-day.

There are three major options to deploy/own and operate a private network:

i. A fully captive physical network (MNO independent Private Network) in a locally licensed enterprise spectrum.

ii. A licensed MNO owns and deploys a virtual private network for a captive user using his MNO licensed spectrum and/or his own core network using network slicing. An alternate option is for the captive user to have his own network using spectrum leased from a MNO. Protected use makes this option attractive for high-end customers.

iii. A captive LTE or 5G network operating in unlicensed spectrum, which is primarily used by Wi-Fi.

Private networks are designed and deployed by enterprises to optimize or enable business processes. Broadly, there are three drivers to deploy a private mobile network:

- To guarantee coverage: Often in locations with harsh radio frequency (RF) or operating conditions or where public network coverage is limited/non-existent (e.g., remote areas).
- To gain network control: For example, to apply configurations that are not supported in a public network. Security and data privacy are also important. The ability to retain sensitive operational data on-premises is crucial to high tech industrial companies.
- To meet a performance profile: Specifically, a profile that will support demanding applications. 5G has a clear performance advantage over LTE and Wi-Fi in cyber-physical industrial systems.

Both physical and virtual private IMT networks need to operate in frequency bands identified for IMT in order to benefit from the economies of scale of the global IMT ecosystem. A virtual private network may be deployed in areas where there is coverage by MNO network(s), whereas a physical private network can be deployed anywhere; from metropolitan to rural, to remote areas; where access to enterprise spectrum for locally licensed private networks is available. Unlike MNO networks that need spectrum that is authorized over wide geographical areas on an exclusive basis, locally licensed private networks can be implemented using spectrum authorization on a shared basis.

The choice of which geographic areas and frequency band(s) for spectrum sharing by locally licensednetworks is determined at the national level. The method of spectrum allocation used to grant spectrum access to locally licensed private networks to enable spectrum sharing is also a national decision.

[Examples of IMT frequency bands in which locally licensed private networks have been deployed or are being planned include:

Country	Frequency and Remarks
USA	• 3.5 GHz CBRS (Citizen broadband radio service), exclusive & shared licenses, deployments in 2H19 • 37-37.6 GHz shared spectrum/local licenses, under evaluation
Germany	• 3.7-3.8 GHz • 24.25-27.5 GHz, local licenses, expected Q4 2020 • Local licenses. Assignment complete; available 2H 2019
UK	• 3.8-4.2 GHz • 24.25-26.5 GHz, local licenses, applications open since end of 2019 • Local licenses (50 meters square); regulator database; decision formalized; applications invited from end 2019
Sweden	• 3.72-3.8 GHz, in consultations
Finland	• Sub-licensing of 3.4-3.8 GHz • Local permission via operator lease; assignment complete
Netherlands	• 3.5 GHz for local industrial use; 3.7-3.8 GHz (in consultations); 2.3-2.4 GHz (licensed shared access online booking system) • 3.5 GHz for local industrial use; however, users may need to move to 3.7-3.8 GHz, if allocated; 2.3 GHz approved for PMSE (Programme making special event)
France	• 2.6 GHz, regulator database & approval. Up to 40 MHz approved for Professional Mobile Radio
Czech Republic	• 3.4-3.44 GHz for private networks
Brazil	• 3.7-3.8 GHz, under consideration • 27.5-27.9 GHz, allocation completed
Chile	• 3.75-3.8 GHz, allocation completed at end of 2019
Australia	• 24.25-27.5 GHz & 27.5-29.5 GHz for local licensing in 1Q 21. • 3.7-4.2 GHz under consultation for local licensing
New Zealand	• Licenses in 2 575-2 620 MHz may be assigned for localized use
Malaysia	• 26.5-28.1 GHz will be assigned for the deployment of local/private networks
Singapore	• Each operator has acquired 800 MHz of 26/28 GHz spectrum to deploy local networks
Hong Kong	• 24.25-28.35 (400 MHz) available for local licenses
Japan	• Phase 1: 2,575-2,595 MHz (NSA anchor) and 28.2-28.3 GHz; local licenses, legislated in December 2019 • Phase 2: 1 888.5-1 916.6 MHz (NSA anchor), 4.6-4.9 GHz (4.6-4.8 GHz indoor only, 4.8-4.9 GHz outdoor possible) & 28.3-29.1 GHz (150 MHz outdoor use; total 250 MHz range 28.2-28.45 MHz); local license. Legislation in 4Q 2020. Uplink heavy TDD configuration using semi-sync is allowed in sub-6 & 28 GHz

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10 Summary

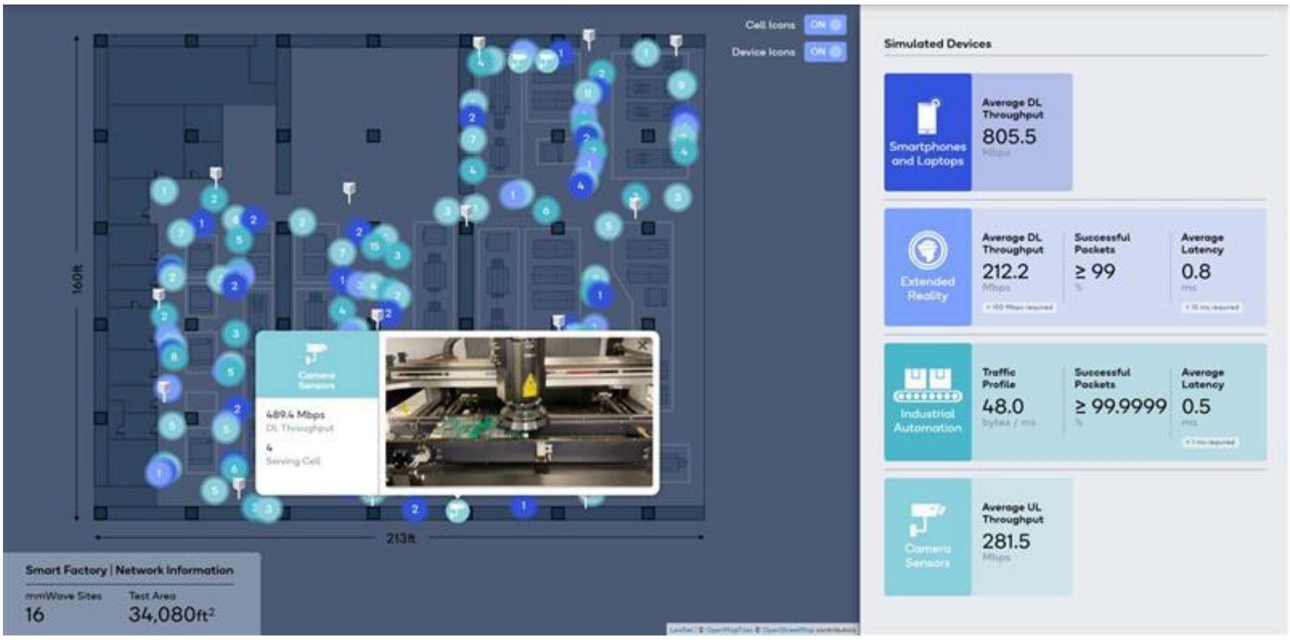
TBD

ANNEX X

Case study of IMT applications in manufacturing

X.1 mmWave in Manufacturing

5G mmWave can support diverse connectivity need in new verticals. As an example, a 5G mmWave private network supporting a smart factory use case was simulated in one case. A smart factory floor map of about 34,000 square feet with a 12 feet ceiling height is simulated. This smart factory layout has 16 mmWave base station sites covering the space, including the factory floor and some office spaces. The mmWave network operates utilizes 800 MHz of bandwidth.



The following kind of devices are part of the smart factory:

Devices	Remarks	Throughput	Latency	Reliability
Smartphones and always connected laptops	General purpose connectivity for personnel and other usages	800 Mbps download		
Boundless XR	Enabling many emerging Industry 4.0 use cases, such as guided maintenance and task execution. To support immersive augmented reality experiences, heavy processing is done on the edge server while lighter-load compute can be processed on-device.	100 Mbps	10 ms latency (Obtained average 0.6 ms latency)	
TSN	To enable cutting the wire for extremely high-performance industrial automation use cases		Milliseconds	Six nines 99.9999%
Low complexity IoT devices (RedCap)	Industrial Camera Sensors (100 MHz Bandwidth)	10s of Mbps		

Utilization of mmWave in the smart manufacturing scenario provides the ability to utilize Flexible UL/DL, scenario, and use-case specific configuration of spectrum utilization by devices and greater control on resource utilization.

The following 3GPP features enable the highly scalable and flexible mmWave based manufacturing deployment:

- Time Sensitive Networking (TSN)
- Coordinated Multipoint (CoMP) / Multi TRP (M-TRP)
- URLLC / eURLLC
- MU MIMO – multi user MIMO
- Positioning
- mmWave network.

[Note: Further results on the performance obtained may be included in future]

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