

IoT

- **MTC, M2M or IoT- Communication between devices without human intervention.**
- **Connected “things” - smart phones, sensors, actuators, cameras, vehicles, industrial automation etc., -low to highly complex devices.**
- **Use cases: Based on energy consumption, transmission power, latency requirements, cost, data rate, long range.**

Eco-system growth

- Sensors and actuators to monitor and control the surrounding environment.
- Communication technologies capable of the low consumption power and the wide area coverage.
- Technologies for big data/cloud computing to analyse a big volume of data.
- Evolution of software and hardware for relevant technologies.

Integrated Applications



Information Processing



Network Infrastructure



Sensing and Identification



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Opportunities and challenges

- Target-Consumer as well as industrial markets.
- The number of IoT devices connected is 17.3 billion in 2016 and to grow to 30.0 billion 2020.
- Low cost wireless sensors and Cloud computing drive the IoT.
- Identifying globally harmonised frequency bands facilitates economies of scale.

9.1.8 - Resolution 958 (WRC-15)

- *Urgent studies required in preparation for the 2019 WRC;*

Studies on the technical and operational aspects of radio networks and systems, as well as spectrum needed, including possible harmonized use of spectrum to support the implementation of narrowband and broadband machine-type communication infrastructures, in order to develop Recommendations, Reports and/or Handbooks, as appropriate, and to take appropriate actions within the ITU Radiocommunication Sector (ITU-R) scope of work.

- **RESOLUTION ITU-R 66**

ITU-work plan for AI-9.1.8

- **Meeting No. 24 (14-22 June 2016, Geneva, Switzerland)**
Initial discussions on the working document towards draft CPM text
- **Meeting No. 25 (5-13 October 2016, Geneva, Switzerland)**
 - 1 Update the working document based upon received contributions
 - 2 Liaise with WP 5A and WP 1B
 - 3 Review and revise the work plan as appropriate
- **Meeting No. 26 (14-22 February 2017, Geneva, Switzerland)**
 - 1 Update the working document on draft CPM text based upon received contributions
 - 2 Review and revise the work plan as appropriate
- **Meeting No. 27 (13-21 June 2017, Niagara, Canada)**
 - 1 Update the working document on draft CPM text based upon received contributions
 - 2 Review and revise the work plan as appropriate

ITU-work plan(cont..)

- **Meeting No. 28 (3-11 October 2017, Munich, Germany)**
 - 1 Update the working document on draft CPM text based upon received contributions
 - 2 Liaise with WP 5A and WP 1B as appropriate
 - 3 Review and revise the work plan as appropriate.
- **Meeting No. 29 (31 January – 7 February 2018, Seoul, Korea)**
 - 1 Update the working document on draft CPM text based received contributions
 - 2 Liaise with WP 5A and WP 1B as appropriate
- **Meeting No. 30 (13-20 June 2018, Mexico)**
 - 1 Consider the received contributions
 - 2 Complete discussions on matters related to Res. **958 (WRC-15) Annex 3**
 - 3 Finalize draft CPM text
 - 4 Submit draft CPM text to chapter rapporteur

No spectrum exclusively to MTC

- Analysis of the current and future spectrum use for narrowband and broadband machine type communications (MTC), as expressed in Resolution **958 (WRC-15)**, concluded that there is no need to identify specific spectrum for those applications in the RR.

IoT Classification

- **Fixed & Short Range**

- (i) RFID (ii) Bluetooth (iii) Wi-Fi

- **Long Range technologies**

- (i) Non 3GPP Standards (LPWAN)

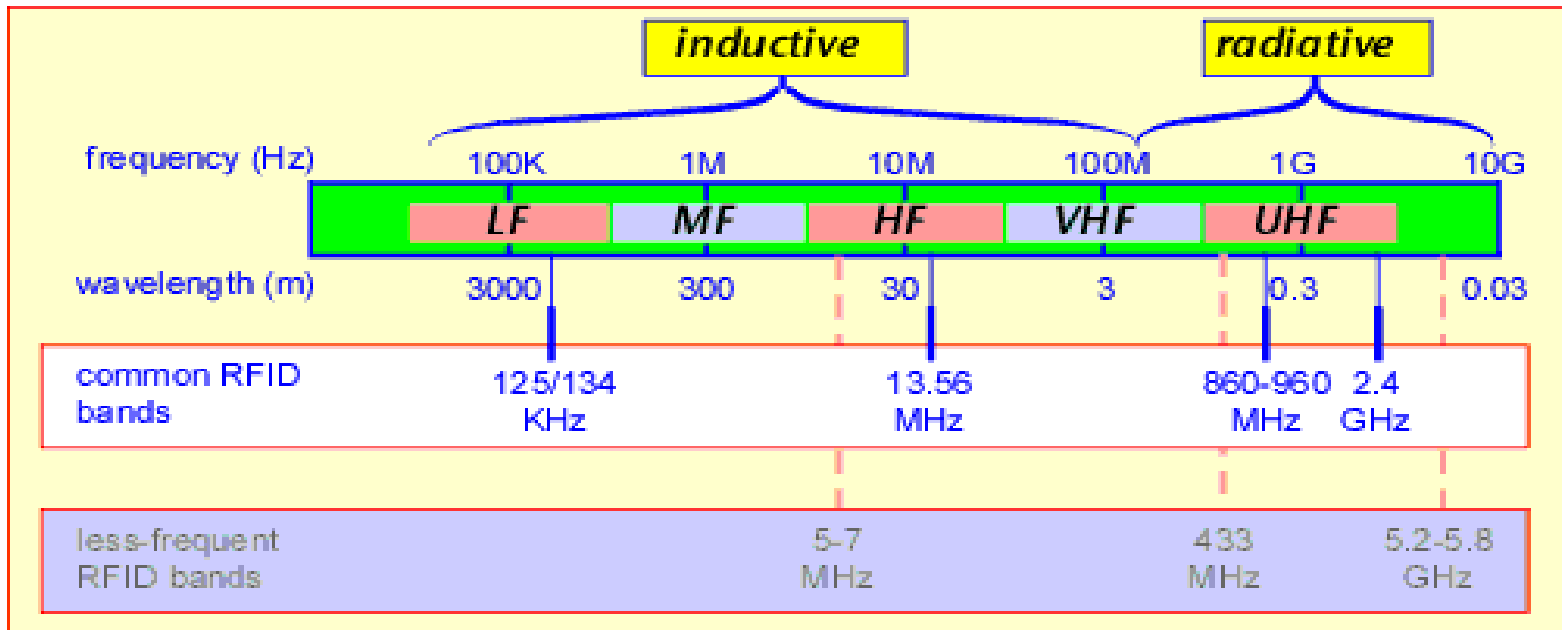
- (a) LoRaWAN (b) Sigfox (c) Weightless

- (ii) 3GPP Standards :-

- (a) LTE-M (b) NB-IOT (c) .EC-GSM (d) 5G -IoT

RFID

- Radio frequencies from 100 kHz to 10 GHz.
- Short or very short range technology.
- Limited to presence detection.



Bluetooth characteristics

- Radio frequency at 2.4 GHz ISM Band.
- Support Data Rate of 1 Mb/s.
- Maximum range 150m.
- Low cost, Low latency, Fast transaction

ZigBee

- Operates on unlicensed bands: -
 - ISM 2.4 GHz at 250 Kbps
 - 868 MHz at 20 Kbps –
 - 915 MHz at 40 Kbps
- Low power.
- Up to 65 000 nodes on a network

WiFi

- Home building and automation.
- Smart energy, Multimedia-audio streaming
- Security, Industrial automation

Standard	Frequency bands	Throughput	Range
WiFi a (802.11a)	5 GHz	54 Mbit/s	10 m
WiFi B (802.11b)	2.4 GHz	11 Mbit/s	140 m
WiFi G (802.11g)	2.4 GHz	54 Mbit/s	140 m
WiFi N (802.11n)	2.4 GHz / 5 GHz	450 Mbit/s	250 m
IEEE 802.11ah (wifi halow)	900 MHz	8 Mbit/s	1KM

Wide-area M2M technologies and IoT

Carrier frequency	Technology	Channel bandwidth	Representative data rate	Link budget target or max. range	
Licensed cellular	LTE Cat. 0	20 MHz	DL: 1 Mb/s UL: 1 Mb/s	140 dB	
	LTE Cat. M	1.4 MHz	DL: 1 Mb/s UL: 1 Mb/s	155 dB	
	NB-IoT	200 kHz	DL: 128 kb/s UL: 64 kb/s	164 dB	
	EC-GSM	200 kHz	DL: 74 kb/s UL: 74 kb/s	164 dB	
Unlicensed	2.4 GHz	Ingenu RPMA	1 MHz	UL: 624 kb/s DL: 156 kb/s	500 km line of sight
	Sub-1 GHz	LoRa chirp spread spectrum	125 kHz	UL: 100 kb/s DL: 100 kb/s	15 km rural 5 km urban
	Sub-1 GHz	Weightless-N	200 Hz	UL: 100 b/s	3 km urban
	Sub-1 GHz	Sigfox	160 Hz	UL: 100 b/s	50 km rural 10 km urban



LoRaWAN

- LoRaWAN is a *Low Power Wide Area Network*
- Long range communication (up to 15 Km)
- 125KHz channels with throughput 50 Kbps
- 915 MHz ISM band in US
- 868 MHz in Europe
- Fire Detection ,Earthquake Early Detection
Smart metering , Fleet management ,Real Time Traffic Management

Sigfox

- Low throughput (100 bps) .
- Extended range up to 50 km)
- 868 MHz in Europe
- 915 MHz in USA

LTE-M

- Interoperability with LTE networks.
- Coverage: up to 11 Km
- Maximum throughput: 1 Mbps .
- Receive bandwidth to 1.4 MHz.

NB-IOT

- Narrowband radio interface
- Receive bandwidth of 200 kHz in downlink and uplink
- Range - 11 Km
- Throughput- 150 Kbps

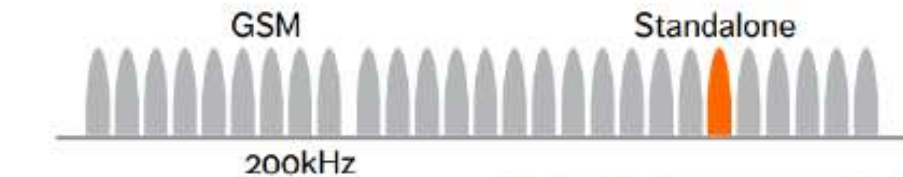
Spectrum and access

- Designed with a number of deployment options for **GSM** , **WCDMA** or **LTE** spectrum to achieve spectrum efficiency.
- Use **licensed spectrum**.

Stand-alone operation

Dedicated spectrum.

Ex.: By **re-farming GSM channels**



Guard band operation

Based on the unused RB within a LTE carrier's **guard-band**



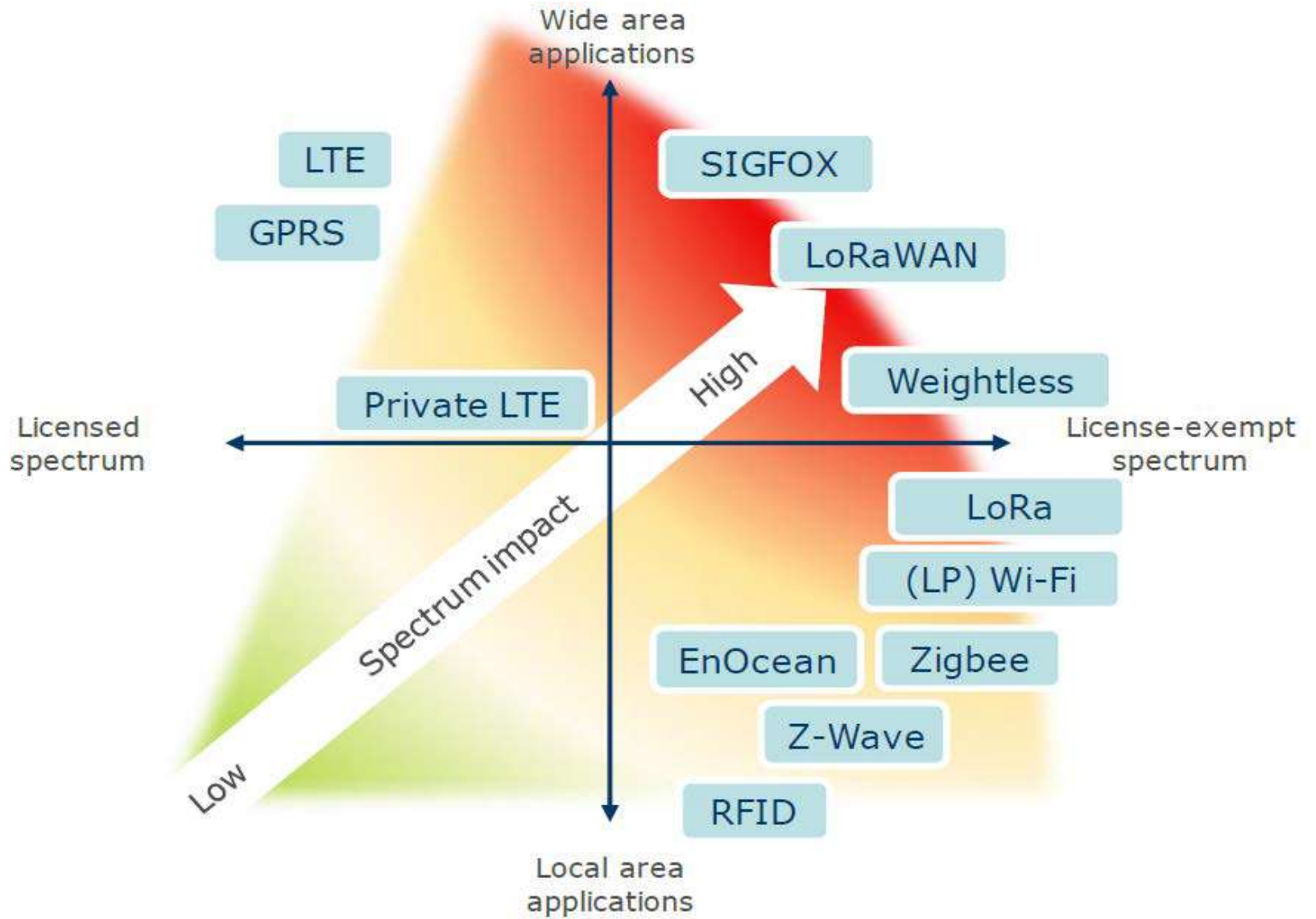
In-band operation

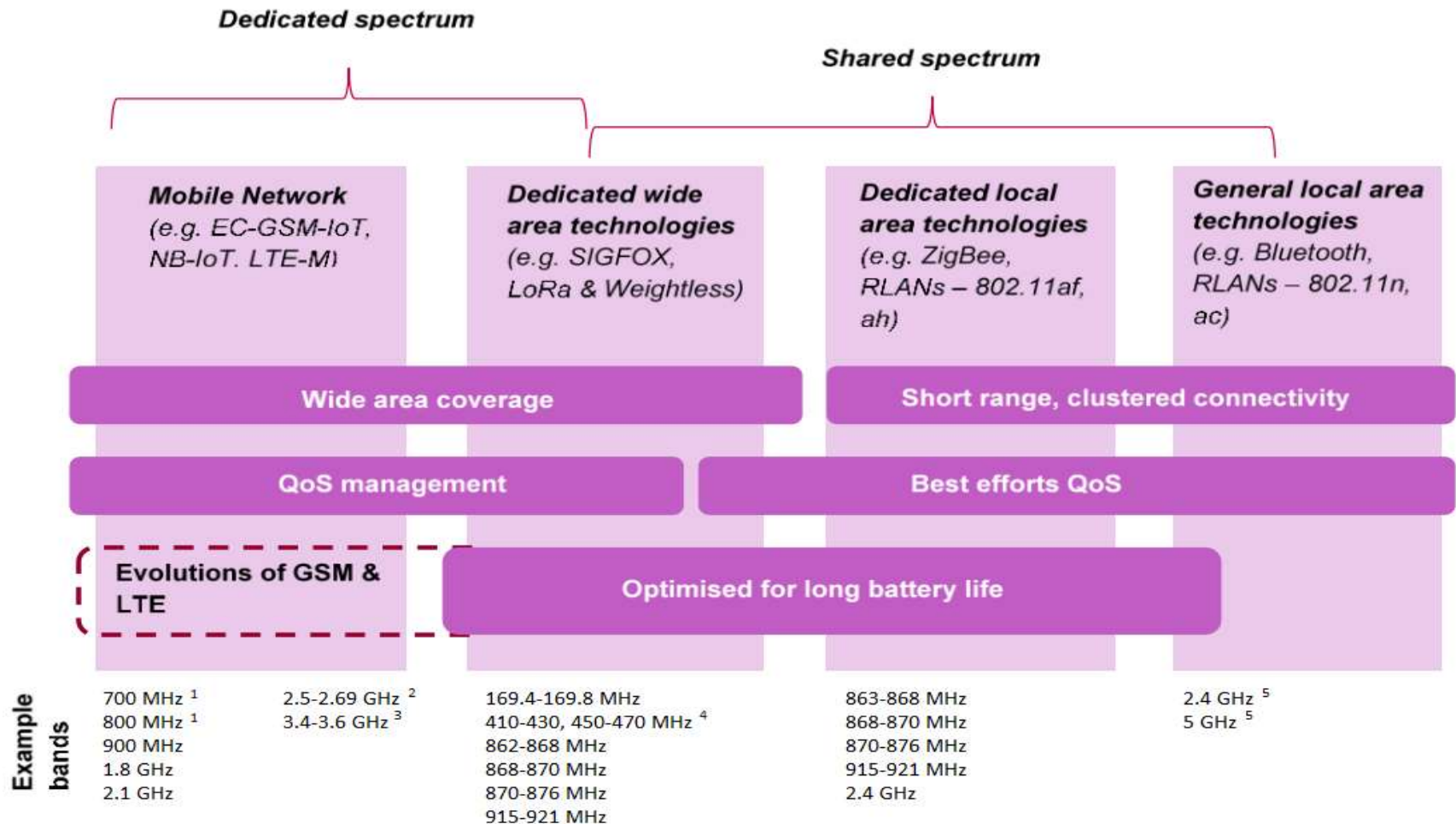
Using **resource blocks** within a normal LTE carrier



EC-GSM

- Adapt and leverage existing 2G infrastructure over GSM Coverage.
- Long battery life.
- Low device cost .
- Range -15 Km
- Throughput- 10 Kbps
- Support for massive number of devices:
50000 devices per cell





Note 1: There are plans to open the 700 MHz and 800 MHz (Digital Dividend bands)

Note 2: The 2.500 - 2.690 GHz bands is open for IMT-2000 and other compatible technologies for the provision of Broadband Wireless Access (BWA) services.

Note 3: The 3.4 - 3.6 GHz band is open for BWA systems.

Note 4: The band 410 - 430, 450 - 470 falls within frequency band currently allocated to PMR / telemetry system.

Note 5: The 2.4 and 5 GHz frequency band already open and used for Bluetooth / WLAN systems.

Usage scenarios for IMT for 2020

- **Enhanced Mobile Broadband –human centric.**

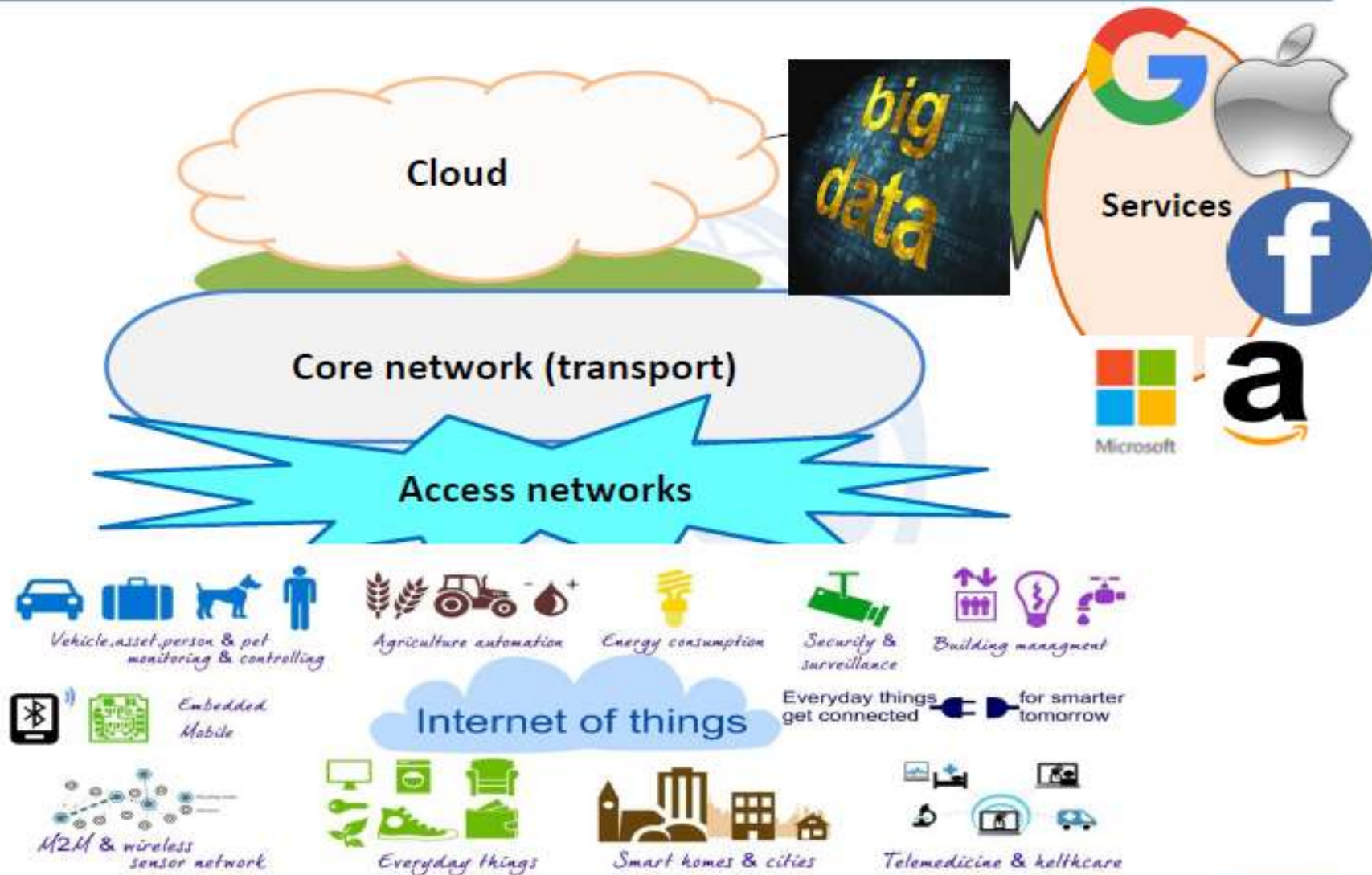
-High mobility and seamless coverage

- **Ultra-reliable and low latency comms.**

-stringent requirements for throughput, latency and availability.

Massive machine type communications.

-very large number of devices transmitting low volume of non-delay-sensitive data.



TRAI-License type- dtd 5th Sept.2017

Service Providers	M2M type	Licensing process
CMTS, UASL, UL (AS) and UL holders	M2M cellular	Additional authorization in existing license
Basic Services licensees and ISP licensees	Unlicensed M2M	Additional authorization in existing license
UL (VNO) holders	M2M cellular	Additional authorization in existing license
WPAN/WLAN Service providers.	Unlicensed M2M	Only registration .
LPWAN service providers	Unlicensed M2M	UL namely UL (M2M).-A,B,C categories.-light license. Can also bid for licensed spectrum

TRAI on spectrum to M2M

- Spectrum allocation technology and service neutral.
- No separate spectrum band is to be allocated exclusively.
- 1 MHz of spectrum from 867-868 MHz and a chunk of 6 MHz of spectrum at 915-935 MHz is to be de-licensed.
- The delicensing the V-band (57-64 GHz).

De-licensed bands

- 2.4-2.483 GHz-indoor/outdoor
- 5.825-5.875 GHz-indoor/outdoor
- 5.15-5.25 GHz-indoor
- 5.725-5.825 GHz -indoor
- 433-434 MHz -indoor
- 865-867 MHz -low power

TRAI recommendation:-

- 867-868 MHz
- 915-935 MHz (6MHz out of this band)
- 57-64 GHz (V-band delicensing)

SRD- RESOLUTION ITU-R 54-2 (*WRC-2015*)

- **Studies are considering LPWAN for IoT in frequency ranges harmonised for SRD operation**
- **SRD provide either unidirectional or bidirectional communication**
- **SRD have low capability of causing interference to other radio equipment.**
- **SRD are permitted to operate on a non-interference and non-protected basis.**

SRD Applications

- **Tele-command Telemetry**
- **Voice and video**
- **Equipment for detecting avalanche victims**
- **Broadband radio local area networks within a building.**
- **Railway applications.**
- **Road transport and traffic telematics.**
- **Inductive applications.**
- **Radio microphones**
- **RF identification systems**
- **Ultra low power active medical implant**
- **Wireless audio applications**

Frequency range	Remarks
9-148.5 kHz	Inductive SRD applications
3 155-3 400 kHz	Inductive SRD applications
6 765-6 795 kHz	Inductive SRD applications ISM band Centre frequency 6 780 kHz
13.553-13.567 MHz	Inductive SRD applications , ISM band (RR No. 5.150) Centre frequency 13.560 MHz
26.957-27.283 MHz	Inductive SRD applications/non-specific SRDs ISM band Centre frequency 27 120 kHz
40.66-40.7 MHz	ISM band ,Centre frequency 40.68 MHz
2 400-2 500 MHz	ISM band Centre frequency 2 450 MHz
5 725-5 875 MHz	ISM band Centre frequency 5 800 MHz
24.00-24.25 GHz	ISM band Centre frequency 24.125 GHz
61.0-61.5 GHz	ISM band Centre frequency 61.25 GHz
122-123 GHz	ISM band Centre frequency 122.5 GHz
244-246 GHz	ISM band Centre frequency 245 GHz

Other issues with IoT

- Security – Mirai DDoS attack –malware
 - Low processing and low memory devices
 - A security breach in a connected car or a connected pacemaker can result in loss of life.
- Privacy :-
 - Huge amount of personal data is generated
- Certification :-
 - radio frequency interference,
 - electromagnetic incompatibility issues
 - Higher radiation levels

THANK YOU