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| **Radiocommunication Study Groups** |  |
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| **29 November 2021** |
| **English only** |
| Annex 27 to Working Party 5A Chairman’s Report | |
| WORKING DOCUMENT TOWARDS A PRELIMINARY DRAFT new  REPORT ITU-R M.[LMS.SPEC.NEED.ABOVE.275 GHZ] | |
| Spectrum needs for land-mobile service applications  in the frequency above 275 GHz | |

([Question ITU-R 256-1/5](https://www.itu.int/pub/R-QUE-SG05.256))

# 1 Introduction

*[TBD]*

# 2 Scope

This Report addresses the estimation of the spectrum needs for land-mobile service applications operating in the frequency above 275 GHz.

# 3 Related Recommendations and Reports

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| --- | --- |
| Report [ITU-M.2417](https://www.itu.int/pub/R-REP-M.2417) | Technical and operational characteristics of land-mobile service applications in the frequency range 275-450 GHz |
|  |  |

**4 List of acronyms and abbreviations**

|  |  |
| --- | --- |
| *[TBD]* |  |
|  |  |

# 5 LMS applications operating in the frequency above 275 GHz

## 5.1 Requirements of LMS applications

*[TBD]*

## 5.2 Technologies to support high-speed data rates

*[TBD]*

# 6 Estimation of spectrum needs

## 6.1 CPMS applications

Ultra-high definition television (UHDTV) or 8K videos whose uncompressed streaming data rates are 24 Gb/s, 48 Gb/s, 96 Gb/s and 144 Gb/s depending on frame rates from 30 to 120 fps will be serviced by digital platformers for CPMS application. In order to transmit and receive the maximum uncompressed streaming data of 144 Gbit/s, the required bandwidth of those transceivers which have SISO, 2 × 2 MIMO and 4 × 4 MIMO transmission capabilities varies from 6 to 24 GHz and 4.5 to 18 GHz whose modulation schemes are 64-QAM and 256-QAM, respectively. The frequency bandwidth of 50 GHz introduced in section 8.1 is sufficient to meet the requirement for 8K video uncompressed video transmission. However, CPMS applications, in particular, automatic turnstile downloading mobile systems are designed to transfer ultra-high-speed data between mobile terminal and automatic turnstile transceivers. One-hour 8K video size is, e.g., 22 GB in the condition of a frame rate of 59.94, a colour depth of 8 bit/px and HEVC (High Efficiency Video Coding) codec[[1]](#footnote-1). Table 6 summarizes the relationship between high-volume video size and file downloading time as a function of data rates. Since the duration of contact between CPMS devices at the automatic turnstile is around 250 msec and the link setup time between CPMS devices is 2 msec [4]. In order to download high-volume video content such as 22 GB within 248 msec, the data rate of 745 Gbit/s is required which corresponds to the estimated spectrum of 46 GHz. This estimation is based on the modulation scheme of 256-QAM and transmission techniques of 2 × 2 MIMO. The range of spectrum needs for CPMS applications changes depending on system parameters, but the frequency bandwidth around 50 GHz could provide sufficient downloading time for CPMS devices at the automatic turnstile.

TABLE 6

Estimated downloading time of high-volume video content

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Video size (GB/hour) | Downloading time (sec) | | | | |
| 10 Gbit/s | 50 Gbit/s | 100 Gbit/s | 500 Gbit/s | 1 000 Gbit/s |
| 1 | 0.84 | 0.17 | 0.08 | 0.017 | 0.008 |
| 5 | 4.2 | 0.84 | 0.42 | 0.08 | 0.04 |
| 10 | 8.4 | 1.7 | 0.84 | 0.17 | 0.08 |
| 50 | 41.9 | 8.4 | 4.2 | 0.84 | 0.42 |

## 6.2 Wireless links in data centres

High-speed optical links could be replaced with wireless links in two-tier (spine-leaf) or three-tier architectures consisting of two or three layers between servers and core networks, respectively. Each layer has high-speed switches which are known as access, aggregation/distribution and core switches. Access switches are the traditional Top-of-Rack (TOR) switch that consists of 24-48 ports with access layer connections in the range of data rates 1-40 Gbit/s. Aggregation/distribution switches are mid-tier speed switches which support data rates of 10-400 Gbit/s. Core switches have the highest throughput in the range of 100-800 Gbit/s. The trend of data rates between each tier is increasing from 25/100 Gbit/s to 100/400 Gbit/s, and data rates between aggregation/distribution and core switches is moving to 400/800 Gbit/s in recent years. Table 5 summarizes estimated spectrum required to support data rates of 100-1 200 Gbit/s under the condition of SISO, 2 × 2 MIMO and 4 × 4 MIMO transmission. The estimated spectrum varies from 2.5 to 200 GHz depending on modulation schemes such as 64-QAM 256-QAM and 1024-QAM, as well as a stream number between transmitters and receivers. Considering 64-QAM modulation scheme which is the maximum multilevel number of modulation schemes in Table 2, and multi-stream spatial multiplexing techniques, spectrum needs for wireless links in data centres could be in the range of 4.2-50 GHz. However, if data rates between each tier need to be increased to construct, e.g., a hyperscale data centre, larger frequency bandwidths than 50 GHz for wireless links may be required.

TABLE 1

Estimated spectrum required to support switching speed of 100-1200 Gbit/s

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Data rate (Gbit/s) | Spectrum (GHz) | | | | | | | | |
| 64-QAM | | | 256-QAM | | | 1024-QAM | | |
| SISO | 2×2 | 4×4 | SISO | 2×2 | 4×4 | SISO | 2×2 | 4×4 |
| 100 | 16.7 | 8.3 | 4.2 | 12.5 | 6.3 | 3.1 | 10 | 5 | 2.5 |
| 400 | 66.7 | 33.3 | 16.7 | 50 | 25 | 12.5 | 40 | 20 | 10 |
| 800 | 133.3 | 66.7 | 33.3 | 100 | 50 | 25 | 80 | 40 | 20 |
| 1200 | 200 | 100 | 50 | 150 | 75 | 37.5 | 120 | 60 | 30 |

## 6.3 Inter-chip communication system

*[TBD]*

## 6.4 Intra-device communications

*[TBD]*

# 7 Summary

*[TBD]*

**8 Bibliography**

*[TBD]*

1. <https://www.macxdvd.com/mac-video-converter-pro/compress-reduce-8k-video-size.htm> [↑](#footnote-ref-1)