DETECON
CONSULTING

Technical Assessment of the CSIR Spectrum Requirement Study

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Executive Summary

The Minister of Telecommunications and Postal services issued draft policy and policy directions to the ICASA on the licensing of high demand spectrum in GG no. 41935 on 27 September 2018. One of the most contentious issues in the draft policy and policy direction is the amount of spectrum that will be set aside for the WOAN. In light of this, the Minister commissioned the Council for Scientific and Industrial Research (CSIR) to conduct a study to estimate the capacity of the WOAN and to determine the spectrum requirements to ensure its viability. This document presents our key findings about the CSIR spectrum requirement study. The assessment does not attempt to advance a particular Telkom position but rather provides an independent view regarding the technical merits of the methodology, assumptions and input parameters employed by the CSIR.

Inconclusive Analysis

Detecon is of the view that the CSIR spectrum requirement study is technically flawed. Our assessment revealed that certain aspects of the methodology and specific input parameters and assumptions lead to either an underestimation or overestimation of the WOAN spectrum requirement. Hence, outputs vary significantly, thereby leading to unreliable results. The net effect of the various technical flaws in the methodology, assumptions and input parameters can only be ascertained by full access to and interrogation of the CSIR model.

Disjoint between Results and Recommendations

There is a clear disjoint between the CSIR's study results and their recommendations regarding the WOAN spectrum requirement. The CSIR study concludes that the WOAN requires 33.5 MHz of spectrum, which is later rounded to 40 MHz. The CSIR then recommends that the WOAN be assigned 115 MHz (2x25 @ 800 + 2x20 @ 2600 + 25 @ 2600) - the deviation from the initial study conclusion is not clear.

In light of the aforementioned, Detecon is of the view that the CSIR study, in its current form, should not be used a basis for crucial spectrum policy decisions.

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1 Methodology

1.1 Average Spectrum Requirement

The proposed methodology computes the WOAN spectrum requirement by averaging the spectrum requirement across all high and low traffic volume sites. This formulation is technically incorrect as the WOAN spectrum requirement will be driven solely by high traffic volume sites, which typically occur in urban and sub-urban areas.

An example will be used to demonstrate the implications of the aforementioned approach - Consider a real network deployment, where the top 10% of heavily loaded sites are responsible for up to 85% of the total network traffic. By averaging the spectrum requirement over all sites, the top 10% of heavily loaded sites will only be able to carry 10% of the total network traffic as compared to the required 85%.

- **Impact**: Computing the average spectrum requirement over all sites will lead to an underestimation of the actual WOAN spectrum requirement
- **Recommendation**: The WOAN spectrum requirement should be computed based on the average spectrum requirement of the top 10-15% heavily loaded sites

1.2 Virtual Site

In the proposed methodology, a set of WOAN sites are established using the concept of a virtual site. A virtual site combines actual sites that lie within the vicinity of one km of each other. As a result, the actual extent of network densification and its potential impact on both coverage and capacity are not taken into account. This holds particularly true in urban environments where the inter-site distance (ISD) can be well below 1 km.

- **Impact** – Consideration of a subset of all available sites will result in an overestimation of the WOAN spectrum requirement
- **Recommendation** – The entire site grid should be utilized when modelling the WOAN spectrum requirement

1.3 Coverage Gaps

In the proposed methodology, the WOAN cell radii are a function of the intersite distances (ISD) between a particular site and its three closest neighbouring sites. This approach may lead to network coverage gaps in scenarios where there is a large discrepancy between the considered intersite distances. A graphical illustration of a scenario where a coverage gap could potentially materialise is provided in Figure 9 of Annexure D in the abridged spectrum study report.

- **Recommendation** – The entire site grid should be utilized when modelling the WOAN coverage

1.4 Best Practice Methodology For Computing Spectrum Requirement

As an alternative to the CSIR approach, the WOAN spectrum demand could be determined based on a representative hot zone, which experiences the highest traffic volume and thus requires the highest amount of spectrum. It should be noted that these hot zones could be identified via an operator's cell traffic and network statistics reports.

A polygon can then be generated to encompass a particular hot zone. Thereafter, it will be possible to deduce the spectrum requirement based on the total number of subscribers, their average traffic generation in Mbps (including activity factor) during the Busy Hour, typical cell sizes for different frequencies[1], and typical bps/Hz spectral efficiencies.

The following flow chart depicts the main steps of the best practice approach to determine the spectrum demand:

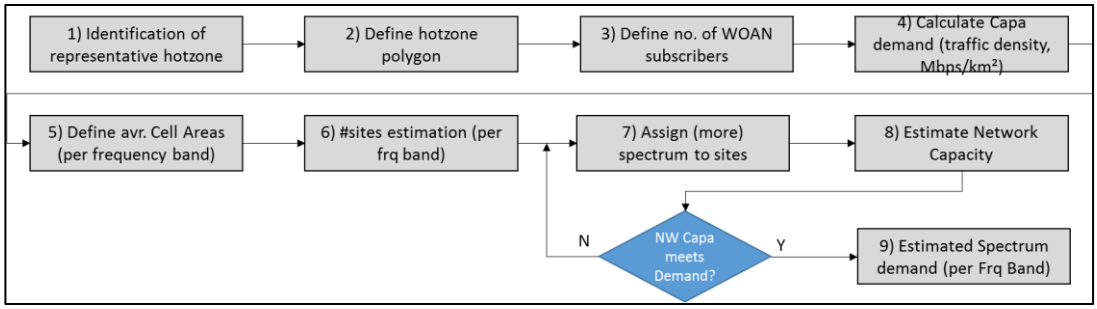

Figure 1. Best Practice Methodology for Computing Spectrum Requirement

1. Analysis of cell load reports of all mobile operators, looking into individual Busy Hour (BH) of mobile operators (time, location)
2. Define hot zone polygon, approximately 10km x 10km
3. WOAN subscribers within polygon: how many, monthly average data volume, BH share, activity factor (concurrent)
4. Capacity Demand: Calculate traffic density
5. Cell Area: typical cell radii (best practice) per frequency band to meet target speed objective.
6. Required Sites Estimation: estimate no of cells per frequency band (#sites: using 3 sectorization) within polygon

[1] considering the target data rates objectives

7. Assign spectrum in 5 MHz chunks: derive offered BH average network capacity (Mbps/km²)
8. Compare network capacity with capacity demand: Terminate iteration when exit criterion is met
9. Result: Estimated spectrum demand

2 Assumptions

2.1 Target Market Served by WOAN

The CSIR study assumes that the WOAN will serve 20% of the mobile market in 2020. This assumption is unrealistic as it suggests that 20% of the entire mobile market (2G, 3G, 4G) will be served by a "4G only" WOAN within a period of less than 2 years. In addition, subscriber projections based on the mobile market in 2020 are not correct, given that the WOAN was dimensioned to meet the 2030 SA connect speed targets.

- **Impact**: Overestimating the size of the mobile market that will be served by the WOAN will result in an overestimation of its spectrum requirement. Conversely, an underestimation of the addressable mobile market will yield an underestimation of the WOAN spectrum requirement
- **Recommendation**: A market assessment should be conducted in order to reliably forecast the size of the 4G market that will be served by the WOAN in 2030. This market assessment must consider the subscriber and traffic forecasts of the all mobile operators. In addition, the impact of new entrants must be factored into the market assessment

2.2 Monthly Data Consumption

The CSIR study assumes monthly usage of 1 GB per user at an average activity factor of 2.5% in the year 2020 based on the CISCO VNI forecast. However, according to the latest publication of the Cisco VNI Forecast[2] for South Africa, the *"mobile traffic per user will reach 4,008 megabytes per month by 2021, up from 564 megabytes per month in 2016, a CAGR of 45%."*. From this, we can deduce that the monthly data consumption per user is ~ 2 GB in 2020 and not 1 GB as claimed by the CSIR. In addition, data consumption

[2] https://www.cisco.com/c/dam/assets/sol/sp/vni/forecast_highlights_mobile/index.html (18th Oct 2018)

projections based on the year 2020 are not correct, given that the WOAN was dimensioned to meet the 2030 SA connect speed targets. Considering the CAGR of 45%, it is evident that monthly data consumption figures in 2030 will be significantly higher than those currently employed by the CSIR.

- **Impact**: Increasing the forecasted monthly usage per subscriber will increase the WOAN spectrum requirement, or even raise the need for (earlier consideration of) new technologies like 5G
- **Recommendation:** A market assessment should be conducted in order to reliably determine the forecasted monthly 4G data consumption per subscriber

3 Technical Parameters

3.1 Downlink Activity Factor

The downlink activity factor of 2.5 % appears to be low by international standards.

- **Impact**: The adoption of higher downlink activity factor will increase the WOAN spectrum requirement
- **Recommendation**: Downlink factors of between 7-10% are typically encountered in 4G networks

3.2 Traffic Distribution

It is unclear why a 3G traffic distribution was utilised for the WOAN, which is clearly a 4G only network. 4G networks are characterised by higher downlink activity factors due to the greater consumption of multimedia content as compared to 3G networks.

- **Impact**: The adoption of the correct 4G traffic distribution and the resulting higher downlink activity factor will increase the WOAN spectrum requirement.
- **Recommendation**: Use of a suitable 4G traffic profile

3.3 Area Spectral Efficiencies

The area spectral efficiency figures, as per ITU Recommendations, are higher than those found for existing and projected systems. For instance, ITU-R M.2290 uses values for RAT

Group 2 (4G) ranging from 4 to 7.3 bps/Hz/cell, whilst Nokia fellows Holma and Toskala[3] give a figure of 1.75 bps/Hz/cell (downlink).

Another point for criticism is that the ITU model does not distinguish between uplink (UL) and downlink (DL) figures, which is not the case in real networks. In contrast, Holma & Toskala differentiate between UL and DL, with UL figures as low as 0.75 bps/Hz/cell.

- **Impact**: The use of higher spectral efficiencies will underestimate the WOAN spectrum requirement
- **Recommendation**: Use spectral efficiencies that are encountered in practical network deployments

4 Study Outcomes

There is a disjoint between the “Results” of the Study itself and the “Recommendations” provided thereafter. The CSIR study concludes that the WOAN requires 33.5 MHz of spectrum, which is later rounded to 40 MHz. Yet, CSIR makes a final recommendation to set-aside 115 MHz for the WOAN across the three spectrum bands (2x25@800 + 2x20@2600 + 1x25@2600). There is no clear technical justification for CSIR’s deviation from their initial study result.

End of Document

[3] Harri Holma and Antti Toskala: LTE for UMTS, Evolution to LTE-Advanced, 2nd edition, John Wiley & Sons, 2011