Network KPI Analysis in Network Sharing Technology
Configuration Based on Multi-Operator Core Network (MOCN)

Andreas Gunawan Widiantoro¹, Neily Tjahjamooniarsih², Jannus Marpaung²
¹Electrical Engineering Study Program, University of Tanjungpura, Pontianak, Indonesia
²Department of Electrical Engineering, Faculty of Engineering, University of Tanjungpura, Pontianak, Indonesia

Article Info
Received August 10, 2023
Revised August 23, 2023
Accepted August 31, 2023

Keywords:
KPI Network
MOCN Technology
Not Pair Technology
Base Transceiver Station
Network Sharing

ABSTRACT
The reliable spread of BTS networks with high system capacity poses a challenge for operators in delivering services. An alternative strategy is network sharing, one of which is MOCN (Multi Operator Core Network). MOCN BTS is configured to share RF module and antenna resources by combining frequencies between operators while maintaining each operator's core. On the other hand, BTS not-pair is the conventional operator configuration where RF modules and antennas are installed independently without any connection to other operators. In this final project, a KPI data analysis is conducted for both BTS configuration to assess their reliability. Four BTS samples from two operators (IM3 and 3ID) are taken for this analysis. The analyzed KPI categories include Accessibility KPI, Retainability KPI, and Service Integrity KPI during busy hours. KPI data is obtained from field results and assisted by the technical team from Indosat Ooredoo Hutchison Pontianak. The analysis results indicate that in terms of Service Integrity KPI, BTS MOCN outperforms BTS not-pair, with a difference of 2.590175 Mbps for downlink and 0.286065 Mbps for uplink. Regarding Accessibility KPI and Retainability KPI, BTS managed by 3ID demonstrates better performance compared to those managed by IM3.

1. INTRODUCTION
Distribution of reliable BTS networks with high system capacity, especially in new areas, pose challenges for Mobile Network Operator (MNO) in procuring devices and installations for upgrading or establishing new towers [1][5]. To overcome this, some MNOs need to prepare strategy, one of which is network sharing. Network sharing model between MNOs becomes an alternative to developing telecommunications companies in various countries because it allows sharing of spectrum and BTS in the same working scheme. Network sharing can be a solution to expedite network deployment, especially in rural or remote areas [2]. One of the five network sharing models is Multi Operator Core Network (MOCN). MOCN is a collaborative telecommunications network architecture proposed by multiple MNOs to integrate or utilize network resources together. MOCN is vital in the mobile telecommunications industry, especially in the context of network virtualization and technology. It can help MNOs reduce investment costs in network infrastructure while maintaining high-quality services. The basic idea behind MOCN arrangement is that one Radio Access Network (eNodeB) will provide network access to multiple MNOs, where each MNO maintains its core network. MNOs can also combine their frequencies to increase capacity. The integration of MOCN will extend network coverage and enhance capacity, resulting in better network quality for users [3][6]. In line of this, the author seizes the opportunity of this MOCN as the research topic for the final project. The author focuses on the analysis of Key Performance Indicators (KPI) for the BTS MOCN network (pair colocation) and the standalone BTS network (not-pair), comparing their KPI performances to determine whether using the BTS MOCN network or BTS not-pair network yields better results. The objective of this study is to obtain technical findings regarding the reliability of BTS MOCN compared to BTS not-pair networks.

2. LITERATURE REVIEW
The network sharing model is where operators or MNOs (Mobile Network Operators), as service providers, share the utilization of telecommunications network infrastructure, encompassing passive infrastructure (passive sharing) and active infrastructure (active sharing), both on the radio access network side and on the core network side[9][14][15].
2.1. MOCN and Not Pair

MOCN is a configuration that shares RF module and antenna resources by combining the frequencies of two MNOs while maintaining each MNO's core network. MOCN can be applied to two or more MNOs, with one of them acting as the Master Operator (MOP). On the other hand, a not pair BTS is a configuration done by an operator, where the RF module and antenna are installed separately without any connection to other operators[4][7][8]. To compare performance of both configurations, network KPIs are needed to identify network outputs in accordance with the quality boundaries. In 4G LTE, network KPIs are classified into 5 categories, including Accessibility, Retainability, and Service Integrity[10][11][12].

![Figure 1. Base Transceiver Station Configuration (a) Not Pair Technology (b) MOCN Technology]

2.2. Accessibility KPI

Accessibility KPI refers to the measurement of how much the network services are available or accessible to users. The Accessibility KPI in 4G LTE consists of several important parameter that assess the network's ability to provide services to users. Some of the key components of the Accessibility KPI in 4G LTE include: S1 Signaling Success Rate, Radio Resource Controller Setup Success Rate, ERAB Setup Success Rate, Call Setup Success Rate, and Circuit Switch Fall Back Success Rate.

2.3. Retainability KPI

Retainability KPI used in mobile networks to measure and monitor the network's ability to maintain established connections or services with users over a specific period without interruptions or disruptions. The Retainability KPI in 4G LTE include Drop Call Rate.

2.4. Service Integrity KPI

Service Integrity KPI used in a mobile network to measure and monitor the integrity or quality of services provided to users during a specific period of time. The key components of the Service Integrity KPI in 4G LTE include: Downlink Throughput and Uplink Throughput.

3. METHOD

3.1. Equipment

In this research, in general, the following tools are needed:

<table>
<thead>
<tr>
<th>No</th>
<th>Equipment</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Laptop</td>
<td>1 pcs</td>
</tr>
<tr>
<td>2</td>
<td>LAN cable</td>
<td>1 pcs</td>
</tr>
<tr>
<td>3</td>
<td>Site Sample</td>
<td>4 site</td>
</tr>
</tbody>
</table>

3.2. Research Samples

The research was conducted by collecting network KPI data from 4 (four) sample sites according to the research scenario. These sites include LTE_DANAU_SENTARUM_PL located on Danau Sentarum Street with MOCN configuration where IM3 serves as the Master Operator, LTE_KOTA_BARU_PTK_PL situated on Wonobaru 1 alley with MOCN configuration where 3ID acts as the Master Operator, IM3 LTE_SANTIKA_PONTIANAK_EP on Diponegoro Street with a non-pair configuration, and 3ID LTE_SANTIKA_PONTIANAK_EP on Diponegoro Street with a non-pair configuration.
Network KPI Analysis in Network Sharing Technology Configuration Based on Multi-Operator Core Network (MOCN) (Andreas Gunawan Widiantoro)

3.3. Research Methods

The research method used in this study is described in a flowchart as outlined in Figure 3 as follows:

a. Expert Consultation
Discussions were held by the author with the Head of Technical Officer at Indosat Ooredoo Hutchison Pontianak in person, and the Regional Kalimantan Network Planning Team in Balikpapan via Teams. These discussions aimed to gather data related to current telecommunications issues, existing BTS (Base
Transceiver Station) data, theories, regulations, and the development of Multi-Operator Core Network implementation at PT. Indosat Ooredoo Hutchison.

b. Study Literature

Study literature was conducted to find supporting theories about Multi-Operator Core Network and to study secondary data about the existing BTS of PT. Indosat Ooredoo Hutchison in the Pontianak area, as well as 4G network KPI parameters.

c. Selection of Sites According to Research Scenarios

This research selected 4 (four) sample sites in Pontianak city according to the research scenarios. These sites include sites with MOCN configuration where IM3 serves as the Master Operator, sites with MOCN configuration where 3ID serves as the Master Operator, IM3 sites with non-pair configuration, and 3ID sites with non-pair configuration. The selection of these four sites for KPI Network data collection in this study was based on the master operation of the BTS and the similarity of technology used on the BTS (L900/L1800/L2100).

d. Data Collection

In this stage, the author conducted direct data collection at the Base Station Controller (BSC) owned by PT. Indosat Ooredoo Hutchinson Pontianak. During data collection, the researcher obtained Primary data in the form of KPI Network data from the four sample sites according to the research scenarios in the Pontianak city area, with BTS MOCN and BTS not pair configurations. KPI network measurement data was recorded every 60 minutes (1 hour) on the EPC (Evolved Packet Core) server but only stored for 14 days, so multiple data collection efforts were needed to obtain data for a total of 28 days.

---

**Figure 4. Data Collect Flowchart**

The observed KPI data includes, among others: S1 Signaling Success Rate (S1 Signaling SR), Radio Resource Control Setup Success Rate (RRC-SSR), ERAB Setup Success Rate (ERAB-SSR), Call Setup Success Rate Packet Switched (CSSR-PS), Circuit Switched Fall Back Success Rate (CSFB-SR), Drop Call Ratio Packet Switched (DCR-PS), Downlink Throughput, Uplink Throughput.

4. RESULTS AND DISCUSSION

In this final project research, KPI 4G network data was collected on July 4th and July 18th 2023 from the Evolved Packet Core (EPC) server at the Base Station Controller (BSC) owned by PT. Indosat Ooredoo Hutchison Pontianak. The data was collected 4 sample sites according to the research scenarios, namely the LTE_DANAU_SENTARUM_PL site with IM3 as the Master Operator in MOCN configuration, the LTE_KOTA_BARU_PTK_PL site with 3ID as the Master Operator in MOCN configuration, the IM3 LTE_SANTIKA_PONTIANAK_EP site with a not pair configuration, and the 3ID LTE_ABDUL_RAHMAN_PL site with a not pair configuration.
4.1. Analysis and Comparison of S1 Signaling Success Rate

All four research sample sites exhibited good performance in S1 Signaling Success Rate during busy hours, meeting KPI standards above 99%. The highest average S1 Signaling Success Rate was observed in the BTS MOCN 3ID configuration at 99.9966%, followed by BTS not pair 3ID at 99.9944%, BTS not pair IM3 at 99.9808%, and BTS MOCN IM3 at 99.9181%. This indicates that the 3ID-managed BTS still outperforms the IM3-managed BTS in terms of S1 Signaling Success Rate.

![Figure 5. Average Graphic of S1 Signaling Success Rate](image)

4.2. Analysis and Comparison of RRC Setup Success Rate

All four research sample sites demonstrated good performance in RRC Setup Success Rate during busy hours, meeting KPI standards above 99%. The highest average RCC Setup Success Rate was recorded in the BTS MOCN 3ID configuration at 99.9829%, followed by BTS not pair 3ID at 99.9326%, BTS MOCN IM3 at 99.9172%, and BTS not pair IM3 at 99.7843%. This indicates that the 3ID-managed BTS still outperforms the IM3-managed BTS in terms of RRC Setup Success Rate.

![Figure 6. Average Graphic of RRC Setup Success Rate](image)

4.3. Analysis and Comparison of ERAB Setup Success Rate

All four research sample sites exhibited good performance in ERAB Setup Success Rate during busy hours, meeting KPI standards above 99%. The highest average ERAB Setup Success Rate was observed in the BTS not pair 3ID configuration at 99.8949%, followed by BTS not pair IM3 at 99.8826%, BTS MOCN 3ID at 99.8344%, and BTS MOCN IM3 at 99.8146%. This indicates that the not pair BTS configuration is superior to the MOCN BTS configuration in terms of ERAB Setup Success Rate.
4.4. Analysis and Comparison of Call Setup Success Rate

All four research sample sites showed good performance in Call Setup Success Rate during busy hours, meeting KPI standards above 98%. The highest average Call Setup Success Rate was observed in the BTS not pair 3ID configuration at 99.9642%, followed by BTS MOCN 3ID at 99.9576%, BTS MOCN IM3 at 99.6506%, and BTS not pair IM3 at 99.6485%. This indicates that the 3ID-managed BTS still outperforms the IM3-managed BTS in terms of Call Setup Success Rate.

4.5. Analysis and Comparison of CSFB Success Rate

All four research sample sites demonstrated good performance in CSFB Success Rate during busy hours, meeting KPI standards above 98%. The highest average CSFB Success Rate was recorded in the BTS MOCN IM3 configuration at 99.9922%, followed by BTS MOCN 3ID at 99.9900%, BTS not pair IM3 at 99.9631%, and BTS not pair 3ID at 99.9612%. This indicates that the MOCN BTS configuration is superior to the not pair BTS configuration in terms of CSFB Success Rate.

4.6. Analysis and Comparison of Drop Call Rate

All four research sample sites exhibited good performance in Drop Call Rate during busy hours, meeting KPI standards below 2%. The best average Drop Call Rate was observed in the BTS MOCN 3ID configuration at...
0.0002%, BTS not pair 3ID at 0.0004%, BTS MOCN IM3 at 0.0017%, and BTS not pair IM3 at 0.0020%. This indicates that the 3ID-managed BTS still outperforms the IM3-managed BTS in terms of Drop Call Rate.

4.7. Analysis and Comparison of Call Setup Success Rate

BTS MOCN IM3 and 3ID, as well as BTS not pair 3ID, demonstrated good Downlink Throughput performance during busy hours, meeting KPI standards above 10 Mbps. However, BTS not pair IM3 showed a decrease in performance during busy hours, failing to meet the KPI standard of 10 Mbps. The best average Downlink Throughput was recorded in the BTS MOCN 3ID configuration at 15.75 Mbps, followed by BTS MOCN IM3 at 15.18 Mbps, BTS not pair 3ID at 13.16 Mbps, and BTS not pair IM3 at 10.82 Mbps. This indicates that the MOCN BTS configuration is superior to the not pair BTS configuration in terms of Downlink Throughput.

4.8. Analysis and Comparison of Call Setup Success Rate

BTS MOCN IM3 and 3ID, as well as BTS not pair 3ID, demonstrated good Uplink Throughput performance during busy hours, meeting KPI standards above 2 Mbps. However, BTS not pair IM3 showed a decrease in performance during busy hours, failing to meet the KPI standard of 2 Mbps. The best average Uplink Throughput was observed in the BTS MOCN IM3 configuration at 2.54 Mbps, followed by BTS MOCN 3ID at 2.26 Mbps, BTS not pair 3ID at 2.25 Mbps, and BTS not pair IM3 at 1.27 Mbps. This indicates that the MOCN BTS configuration is superior to the not pair BTS configuration in terms of Uplink Throughput.
5. CONCLUSION

Based on the analysis results of the network KPIs that have been carried out, the following conclusions are obtained: 1) BTS MOCN is better than BTS not-pair in terms of Service Integrity KPI (Downlink and Uplink Throughput). In terms of Accessibility KPI and Retainability KPI, BTS managed by 3ID is still better than BTS managed by IM3. 2) The success of network KPIs in 4G LTE is not only based on Accessibility KPIs (S1 Signaling, RRC Setup, ERAB Setup, CSSR, CSFB), Retainability KPI (DCR), and Service Integrity KPI (Downlink and Uplink Throughput), but also includes Availability KPI (4G Coverage) and Mobility KPI (Handover). 3) The values of these network KPI parameters are heavily influenced by the user traffic and busy hour based on the highest Data Traffic and Physical Resource Blocks. The more users accessing the eNodeB, the signal reception and data service quality (downlink and uplink) may also decrease network KPI parameters due to the concept of shared spectrum allocation. The values of these network KPI parameters can also be affected by factors such as inadequate infrastructure configuration settings and environmental factors like bad weather or surrounding building structures.

ACKNOWLEDGEMENTS

The author thanked the chairman and academic civitas of the Faculty of Engineering University of Tanjungpura and all the parties involved in the preparation of this journal. May the results of this research be of benefit to both the author and the reader.

REFERENCES