Performance Analysis of VSAT (Very Small Aperture Terminal) Dynamic Single Channel per Carrier

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***Abstract*— This paper presents a performance analysis of Dynamic Single Channel per Carrier (dSCPC) technology in Very Small Aperture Terminal (VSAT) systems, focusing on bandwidth efficiency and link quality. Through field measurements at the Telkomsat HUB Surabaya, the study compares the bandwidth utilization of VSAT dSCPC against conventional VSAT IP for the VSAT Colo Surabaya terminal. The analysis employs link budget calculations to evaluate the signal-to-noise ratio (E_s/N_0). Measurement results show an average E_s/N_0 of 12.05 dB, closely matching the calculated value of 12.002 dB, with a negligible difference of 0.068 dB. The study demonstrates that the dSCPC system achieves a 35% reduction in bandwidth consumption compared to the IP-based system while maintaining superior link margin and more stable resource allocation for terminals with low traffic demand. These findings confirm that dSCPC offers a more efficient satellite bandwidth management solution, optimizing resource utilization without compromising link quality.**

***Keywords*— Dynamic SCPC (dSCPC), VSAT Performance, Bandwidth Efficiency, Link Budget Analysis, E_s/N_0 Measurement, Satellite.**

I. INTRODUCTION

The expansive archipelagic geography of Indonesia poses a significant and persistent barrier to achieving nationwide digital connectivity through conventional terrestrial means [1]. Deploying fiber-optic cables or microwave relay towers across thousands of islands is frequently hindered by prohibitive costs, complex logistics, and challenging terrain, leaving numerous remote, rural, and maritime communities underserved [2]. In this context, satellite communication systems have become an indispensable technological backbone, offering a reliable and comprehensive coverage solution that transcends geographical constraints and is vital for national integration and socio-economic development [3], [4].

Very Small Aperture Terminal (VSAT) networks, a cornerstone of modern satellite communications, are particularly well-suited to address these connectivity gaps due to their rapid deployability and support for interactive, bidirectional data services [5]. In operational environments, two dominant VSAT architectures are prevalent. The first is the shared-resource VSAT IP network, which typically employs Time Division Multiple Access (TDMA). While this approach offers cost-effectiveness for sporadic data traffic by allowing multiple remote terminals to contend for a common bandwidth pool, it suffers from inherent drawbacks. Under high load, these networks experience increased latency, jitter, and potential packet loss, which can critically degrade performance for real-time and quality-of-service (QoS)-sensitive applications such as voice-over-IP (VoIP), videoconferencing, and financial transactions [6], [7].

The second architecture is the conventional Single Channel per Carrier (SCPC) system, which dedicates a fixed-frequency carrier with a constant symbol rate and modulation to each terminal. This method guarantees superior and consistent link performance, characterized by low latency and high availability, making it ideal for premium, constant-bit-rate services [8]. However, its primary deficiency is spectral inefficiency; the allocated bandwidth remains reserved for a terminal regardless of its actual traffic activity, preventing the dynamic reallocation of resources to other users within the network during idle periods [9].

To synthesize the guaranteed performance of SCPC with the statistical multiplexing efficiency of shared networks, Dynamic Single Channel per Carrier (dSCPC) technology has been developed. This advanced scheme represents a paradigm shift by enabling real-time, adaptive allocation of satellite resources [10]. In a VSAT dSCPC network, key transmission parameters—including carrier bandwidth, symbol rate, and modulation and coding scheme (ModCod)—can be dynamically adjusted on a per-terminal basis. This adaptation is driven by sophisticated Bandwidth-on-Demand (BoD) algorithms that respond to instantaneous traffic requirements and is further optimized by Adaptive Coding and Modulation (ACM), which adjusts the ModCod to maintain link robustness under varying atmospheric conditions [11], [12]. This capability allows the network to provide "bandwidth assurance" when needed while reclaiming and redistributing resources during low-activity periods, thereby maximizing the overall efficiency of scarce and expensive satellite transponder capacity [13], [14].

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This research conducts a rigorous performance analysis of a commercial VSAT dSCPC implementation, using the operational Telkomsat hub in Surabaya, Indonesia, as a case study. The study quantitatively evaluates critical performance metrics, including dynamic bandwidth allocation efficiency, signal quality measured as Energy-per-symbol to Noise-density ratio (E_s/N_0), and comparative spectral utilization. A controlled comparative analysis is performed against a traditional VSAT IP network operating under analogous service profiles and environmental conditions. The objective is to empirically validate the theoretical efficiencies of the dSCPC paradigm and provide network architects and service providers with data-driven insights for designing more cost-effective, efficient, and high-performance satellite communication infrastructures tailored to geographically dispersed regions.

II. METHOD

This research was conducted at Telkomsat HUB Surabaya. In this research, several parameters were measured which were written in the measurement process to obtain the final results, namely the quality parameters Es/No. The Es/No value is used by VSAT modems as a measure of signal quality on a satellite communications link. This research also calculates the network link budget to obtain the Es/No value which is then compared with the measurement results. This comparison was carried out to find out how well the VSAT communication network performance with the dSCPC method works.

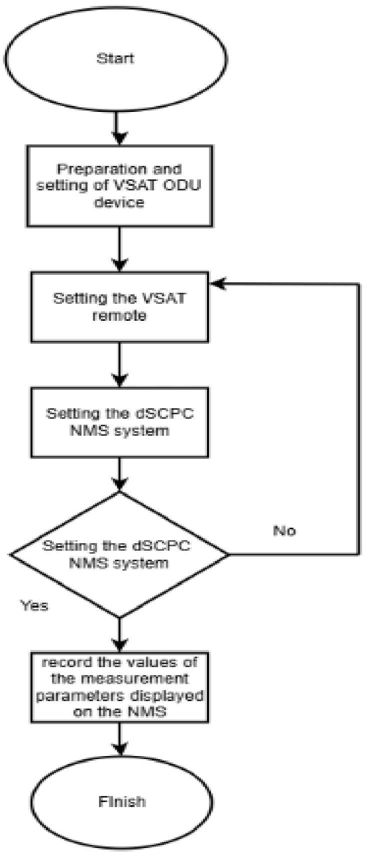

Figure 1. Measurement flowchart

After getting the measurement results, the link budget is then calculated and then compared with the measurement results as a benchmark for VSAT dSCPC Telkomsat Surabaya performance. In this research, satellite communication link budget measurements were carried out using calculations based on the satellite link budget theory formula.

A. *Slant Range(D)*

The slant range between the earth station and the satellite is the actual distance measured from the earth station drawn in a straight line to the satellite position.

$$Z^2 = R^2 + (R+h)^2 - 2R(R+h)cos\beta \qquad (1)$$

Description:
Z = slant range in km
R = radius of the earth (6378 km)
h = satellite orbital height (35786 km)
β = central angle, namely the angle between 2 lines connecting the geocenter.

B. *Effective Isotropic Radiated Power (EIRP) Rx*

Effective Isotropic Radiated Power (EIRP) is the value of satellite power (satellite amplifier output) to transmit downlink frequencies to the receiving earth station.

$$\text{EIRP (Watts)} = P_{TX} \cdot G_{TX} \qquad (2)$$

Information:
P_{TX} = Power Transmitter
G_{TX} = Antenna Gain

C. *Free Speed Loss Uplink (Lfs) up*

Free Space Loss Uplink (Lfs) up or free space attenuation in the uplink direction is free space propagation losses or a reduction in the power of the sending signal during the propagation distance from the sending earth station to the receiving antenna on the satellite.

$$\text{FSL} = 92.4 + 20\log + 20\log(f)_{GHz}(d)_{km} \qquad (3)$$

Information:
d = distance between the earth station and the satellite (slant range)
f = frequency uplink/ downlink in GHz

D. *Figure of Merit(G/T)*

Figure of Merit(G/T) parameter used to show the performance of the antenna and LNA in relation to carrier sensitivity during downlink to the satellite.

$$G/T = 10 \log G - 10 \log T \qquad (4)$$

Note, G = Gain antenna (dB)
T = Receiving system temperature K)

E. *Carrier to noise ratio total$(C/N)_{tot}$*

Carrier to noise ratio total (C/N_{tot}) is a parameter of the end device in satellite communications (receiving ground station).

$$C/N_{tot}(\mathrm{dB}) = +(\frac{C}{N})_{up}^{-1} (\frac{C}{N})_{down}^{-1} \quad (5)$$

Description:

EIRP = Power output from the Transmitter in Watts or dB
L = Propagation attenuation in dB
G/T = Figure of merit in dB
K = Boltzman constant (-228.6)

F. Energy per Bit to Noise Density Ratio (E_b/N_o)

Energy per Bit to Noise Density Ratio (E_b/N_o) is a comparison of the energy per bit noise density of the output of the demodulator in a digital modulation system.

$$E_b/N_o\ (\mathrm{dB}) = -10 \log B C/N_{tot} \quad (6)$$

Note, B = Bandwidth used in bps

G. Energy per Symbol to Noise Density Ratio (I_{ce}/N_o)

Signal quality can also be expressed in terms of energy symbol per noise. Namely the comparison of the symbol energy value with the noise power.

$$E_s / N_o = (E_b/N_o) \times Log_2 M \quad (7)$$

Information, M = Mod where, 8PSK (Mod = 3)

H. Bandwidth

Calculation bandwidth for a carriers determined by the number of bits of information sent. It can be written as follows:

$$Bandwidth = (R_{info}/FEC).\ ()\frac{1+\alpha x}{N} \quad (8)$$

Information:

R_{info} = information bit rate
FEC = Forward Error Correction
N = modulation symbol speed
α = Roll off factor

III. RESULTS AND DISCUSSION

A. Link Budget Calculation

The purpose of Link Budget Analysis is to obtain good and efficient transmission performance for the devices used, especially power and bandwidth allocation. On the VSAT communication path, performance is influenced by the power transmission capability of the satellite (lower path), atmospheric propagation, noise temperature and other parameters. ground station parameters.

TABLE I
TELKOM-4 SATELLITE DATA

Telkom 4 Satellite Data	
Satellite Position	108°ET
EIRPsat	39dBw
Uplink Frequency	4.9GHz
Downlink Frequency	5.1GHz
OBOE	4 dB
G/T sat	8 dB/K

TABLE II
COLO SURABAYA VSAT REMOTE DATA

Parameter	Colo Surabaya VSAT data
Position	-7.33617 LS/112.72366 BT°°
Antenna Diameter	1.8 meters
Bit Rate	132.35 Kbps
FEC	11/15
Modulation	8 PSK
Loss Feeder	2.5 dB
Output Power	55dBW

TABLE III
SURABAYA HUB PARAMETER DATA

Parameter	Surabaya HUB data
Position	-7.33617 LS/112.72366 BT°°
Antenna Diameter	9.2 meters
T Antenna	20K°
T LNB	30K°

TABLE IV
LINK BUDGET MEASUREMENT RESULTS

Parameter	The calculation results
Slant Range	35872.351 km
Free Space loss	197.09 dB
Antenna Gain	36.65 dB
Figure of Merit (G/T)	31.85 dB/k
Bandwidth	63.168KHz
$EIRP_{Sat}$	36.5 dB
$EIRP_{UP}$	89.8 dBW
C/N	55.57 dB
Eb/No	7,573 dB
Ice / No	12.02

B. Calculation of Slant Range and Center Angle

1) Surabaya Earth Station

$\cos\beta = \sin(L_{SB}) sin(L_{SB}) + \cos(L_{SB})\cos(L_{SL})\cos(B_{SL} - B_{SB})$
B= $cos^{-1}\ [sin(7.3661)\sin(0) + \cos(0)\cos\ (108 - 112.7)$
β= 8.7°

Slant Range is calculated by equation (1)

$Z^2 = R^2 + (R+h)^2 - 2R(R+h)\ cos\ \beta$
$= (6378)^2 + ((6378 + 35786)^2 - 2(6378)(6378 + 35786) \cos 8.7\ °$
Z = 35872.351 km

2) Remote VSAT Colo Surabaya

The calculation of the Slant Range and Center Angle on the Remote VSAT Colo Surabaya side is the same as on the HUB side because the coordinate position of the modem is the same.

C. Free Space Loss

1) Surabaya Earth Station

FSL =$92.4 + 20 \log\ (f)_{GHZ} + 20\log(D)_{km}$
FSLUp1 =$92.4 + 20\log\ 4.9_{\ GHZ} + 20\log 35872.35_{\ km}$
= $92.4 + 13.8 + 91.09$ = 197.29 dB
FSLDoqn1 $92.4 + 20\log\ 5.1_{\ GHZ} + 20\log 35872.35_{\ km}$
= $92.4 + 14.15 + 91.09$= 197.09 dB

The FSL calculation results on the remote side have the same results as on the HUB side because the slant range value is the same between the HUB and the remote.

D. Antenna Gain

1) Surabaya Earth Station

G(dB) =$20.4 + 10 \log \eta + 20 \log (f)_{GHZ} + 20 \log D_m$
GUp1 (dB) = $20.4 + 10 \log 0.5 + 20 \log 4.9_{GHZ} + 20 \log 9.2_m$
= $20.4 - 3 + 13.8 + 19.27$ = 50.47 dB
GDoqn1 (dB) = $20.4 + 10 \log 0.5 + 20 \log 5.1_{GHZ} + 20 \log 3.8_m$
= $20.4 - 3 + 14.15 + 19.27$ = 50.82 dB

2) Remote VSAT Colo Surabaya

G(dB) =$20.4 + 10 \log \eta + 20 \log (f)_{GHZ} + 20 \log D_m$
Gup2 (dB) =$20.4 + 10 \log 0.5 + 20 \log 4.9_{GHZ} + 20 \log 1.8_m$
= $20.4 - 3 + 13.8 + 5.1$ = 35.3 dB
GDoqn2 (dB) =$20.4 + 10 \log 0.5 + 20 \log 5.1_{GHZ} + 20 \log 1.8_m$
= $20.4 - 3 + 14.15 + 5.1$ = 36.65 dB

E. Figure of Merit (G/T)

1) G/T Surabaya Earth Station

T(K) = $+\frac{\text{TUp1}}{\text{Lfrx}} + \text{Tf}A\left(1 - \frac{1}{\text{Lfrx}}\right)$ TLNA
Tant = 20°K, Tf = 107°K, = 30°K, Lfrx = 0.5 dB = 1.12 KTLNA
T(K) = $+\frac{20}{1.12} + 107\left(1 - \frac{1}{1.12}\right) 30$
T(K) =$59.3\ °K$
T(K) = = 17.73 dB/K$10 \log 59.3\ °K$
(G/T) HUB (dB/K) = G Down1 (dB) – (T) (dB/K)
= 50.82 – 18.97 = 31.85 dB/K

F. Frequency Bandwidth

Transmission speed and frequency bandwidth:
CIR = 64 Kbps
PIR = 128 Kbps
Minimum Transmission Speed (R) = 64 Kbps
Minimum Transmission Speed (R) = 128 Kbps
Used bandwidth (Occupied bandwidth) per carrier with QPSK ¾ Modulation:

BW min = $\left(\frac{R}{\text{m.FEC}}(1 + \alpha\right) = \left(\frac{64}{2.\frac{3}{4}}(1 + 0.5\right)$ = 44 KHz

Based on the equation, the maximum bandwidth obtained (16APSK ¾) is:
BW max = 80 KHz
Transmission speed at the time of measurement was 132,352 Kbps with 8-PSK modulation and FEC 11/15, so the bandwidth required is:
BW = 63.168KHz = 0.0632 MHz

G. EIRP

Known satellite (= 41 dB$EIRP_{saturasi}EIRP_{saturasiSL}$)
Satellite EIRP = – OBO$EIRP_{saturasiSL}$
= 41 dB – 4.5 dB = 36.5 dB
$EIRP_{SL/carrier}$= Satellite EIRP – 10 logs$\frac{5033}{66.8}$
= 36.5 – 18.77 = 17.73dBW

To calculate the uplink transmitting antenna, namely on the remote side, use the following formula.

$[EIRP]_{dB} = P_{TX}(dBW) + G_{dB}$ = 55 dBWdBi+35.3
= 89.8dBW

Known satellite (= 41 dB$EIRP_{saturasi}EIRP_{saturasiSL}$)

Satellite EIRP = – OBO$EIRP_{saturasiSL}$ = 41 dB – 4.5 dB
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H. Signal Quality (C/N) Return Link

Uplink
C/N_{up}(dB) = $EIRP_{UP} - L_{up} + \frac{G}{T_{sat}} - K - B$ (9)
= $89.8 - 197.29 + 8 + 228.6 - 10 \log 0.0632 \times 10^6$
= 81.11 dB

Downlink
C/N_{down}(dB) = $EIRP_{Sat} - L_{down} + \frac{G}{T_{HUB}} - K - B$ (10)
= $39 - 197.09 + 33.09 + 228.6 - 10 \log 0.0632 \times 10^6$
= 55.59 dB
C/N Total
C/N_{tot}(dB) = $+(\frac{C}{N})_{up}^{-1} (\frac{C}{N})_{down}^{-1}$
= $+(81.11\ dB)^{-1}(55.59\ dB)^{-1}$ = 55.57 dB

I. E_b/N_o

E_b/N_o (dB) = – 10 log BC/N_{tot} (11)
= – 10 log 63168 Hz55.57 dB = 7,573 dB

J. I_{ce}/N_o

I_{ce} / N_o =$(\text{Eb/No}) \times Log_2 M$ (12)
=$7.573 \times Log_2$ 3 = 12,002 dB

K. Device settings and measurements

1) Device Settings

Before taking measurements, you must set up the device, namely by setting the outdoor device and configuring the modem. The outdoor devices consist of LNB (low noise block) and BUC. The parameters required are the transmit frequency (BUC) and receive frequency (LNB).

Namely by installing the antenna device on a support by first assembling the VSAT equipment on the antenna support or boom. After that, install a Coaxial Inter Facility Link (IFL) cable, where you install 2 coaxial cables that are installed with connectors, namely 1 cable to connect the Tx port on the BUC to the Sat port. OUT on the modem. Then 1 other cable to connect the Rx port on the BUC to the Sat.IN port on the modem.

After the outdoor unit has been installed, then conFigure the modem used on the VSAT. In this research, a Newtec modem was used. To conFigure the Newtec modem, several parameters are required to be input into the system so that it can connect to the satellite network. These parameters are input in the Satellite Interface settings.

The HUB device will be connected to the Network Management System (NMS) which is also used to conFigure and create a return link network. In creating a return link network, several stages are required, namely calibrating High Resolution Coding, creating a Return Capacity Group, setting the Service Profile and dividing bandwidth. Return Capacity Group (RCG), this item is used to determine the frequency slot filled by terminals connected to the Return Link network on the HRC demodulator, as shown in Fig. 2.

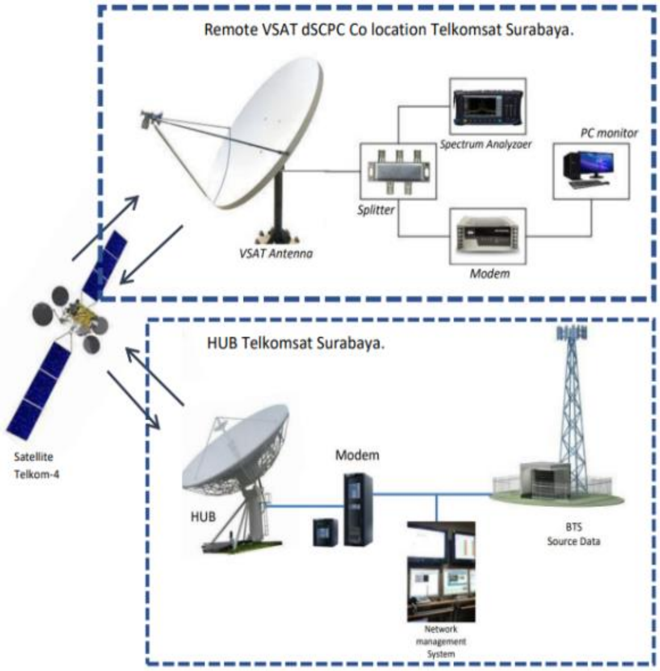

Figure 2. Telkomsat dSCPC VSAT network configuration

This research carried out measurements on the remote side and also the HUB. On the remote side, a spectrum analyzer is used which is connected to the antenna device to obtain Es/No values on the network as in Fig. 2. Meanwhile on the HUB side, the measurement is carried out on the Network Management System by monitoring the required parameter values. These parameters include Es/No, data rate, power and allocated bandwidth.

2) Measurement Results

a. I_{ce}/N_o

Table V is the result of measuring the Es/No parameter which is used as a benchmark for signal quality in satellite communications at the Telkomsat Surabaya HUB. Measurements were carried out 3 times to get the maximum value.

Based on data on the number of PLTS and PLTB plants that will be used and the IEEE 14 bus model that has been designed, the single-line hybrid diagram for PLTS and PLTB plants is as Table V.

TABLE V
RESULTS OF SIGNAL QUALITY MEASUREMENTS ES/NO

Measurement	Tx Power	Ice/No
1	25 dBm	12.07 dB
2	25 dBm	12.03 dB
3	25.02 dBm	12.13 dB
Average		12.07 dB

Table V shows that the average Es/No value is 12.07, which is the value when using 8PSK modulation. From the calculations, the Es/No value is 12,002 dB with the same modulation. So, the margin is 0.068dB. The values obtained in measurements and calculations have met the Es/No quality standards set by the Newtec Modcod sheet, namely for 8PSK modulation with FEC 11/15, the normal value of Es/No obtained is 12dB.

L. Bandwidth Allocation

The HUB / Earth Station will allocate bandwidth according to the application needs of each remote connected to the Return Capacity Group (RCG) system. Return Capacity Group (RCG), this item is used to determine the frequency slot filled by terminals connected to the Return Link network on the HRC demodulator. The parameters input in this item was frequency bandwidth, symbol rate and modulation index. Determines the bandwidth of the initial frequency (start frequency) and final frequency (stop frequency). Then set the maximum symbol rate that can be obtained by a terminal that uses bandwidth at this slot frequency and set the minimum and maximum limits of the modulation index that can be used by the remote user.

The bandwidth used in the RCG for the Return Link is 5 MHz, namely start frequency 6512.743 MHz to stop frequency 6517.743MHz. To find out the bandwidth obtained. In the pictures of measurement results 1, 2 and 3. There is a center frequency tab, which is the middle value of the bandwidth width obtained and is also used to obtain the remote user bandwidth width.

$$Bandwidth_{user1} = (start\ frequenc - center\ frequency) \times 2$$
$$Bandwidth_{user\ 2} = ((start\ frequency + Bandwidth_{user1}) - center\ frequency) \times 2 \qquad (13)$$

Then, for the next user's bandwidth width, the same calculation is carried out by replacing the start frequency value with the previous user's bandwidth width value. Based on the measurement results, the bandwidth width of VSAT colocation Surabaya is obtained:

$$Bandwidth_{Colo\ Surabaya} = (6512.71\ MHz - 6512.7434\ MHz) \times 2$$
$$Bandwidth_{Colo\ Surabaya} = 0.0668\ MHz$$

Each remote user gets a bandwidth that is directly proportional to the bitrate value obtained. The greater the bitrate, the wider the bandwidth will adjust the bitrate value.

Based on measurements that have been carried out 3 times, the remote VSAT Colo Surabaya has not experienced a change in bitrate so that the bandwidth obtained is constant. This is because the signal quality obtained by the Colo Surabaya remote is quite good, so it does not experience significant interference.

Of the total available bandwidth, RCG will use a total of 15 VSAT remotes using this bandwidth service. Bandwidth measurement data can be seen in Table VI.

TABLE VI
BANDWIDTH MEASUREMENT RESULTS

Users	Bandwidth (KHz) (measurement 1)	Bandwidth (KHz) (measurement 2)	Bandwidth (KHz) (measurement 3)	Average Bandwidth (KHz)
Colo Surabaya	66.8	66.8	66.8	66.8
Telkom Ranai	196.4	164	196.4	185.6
GAG Nickel	228.8	196.4	228.8	218
Hexindo Tabang	131.6	131.6	131.6	131.6
Mucindo	164	196.4	196.4	185.6
Pangansari Utama	131.6	164	164	153.2
Bintuni Bay	1135.2	1070	1070.4	1091.8
Hexindo Luweh Hulu	261	229.6	228.8	239.8
Airnav Letung	131.6	130.8	131.6	131.3
Meindo Beautiful Eagle	973.2	909.4	908.6	930.4
Hexindo Kaliorang	131.6	130.8	131.6	131.3
Space Fire Volcano	164	197.2	196.4	185.8
Pinai Religion Office	131.6	163.2	164	152.9
Pinai Religion Office 2	131.6	197.2	196.4	175
Pinai Religion Office 3	487.6	422.2	423	444.2
Accuiring	605.4	605	604.2	

The measurement results showed that the average bandwidth value was 66.8KHz, which is the maximum bandwidth width of the Surabaya Colo VSAT remote user. From the calculations, the bandwidth width is 61.11KHz with the same transmit power. So, the margin of 5.69 KHz.

Based on the measurements carried out, the performance of the Colo Surabaya VSAT remote user has good network quality, because this remote is used as a standard for comparison with other remotes at the location during the installation process. If the Colo Surabaya location gets a good signal, then the condition of the central HUB system is good. no interference occurs.

TABLE VII
COMPARISON OF MODCOD DSCPC VS VSAT IP

ModCod	Es/No VSAT IP (DVB RCS)	Es/No VSAT dSCPC Telkomsat Surabaya	Ice Difference/No
QPSK ¾	6.2 dB	5 dB	1.2 dB
8PSK ¾	9.9 dB	8.8 dB	1.1 dB
8PSK 11/15	13.4 dB	12.05 dB	1.4 dB

The link margin value is a value related to the utilization of the link/network used. VSAT IP whose access method uses TDMA technology must close all links at the link margin value so that it does not affect the utilization of the terminals attached to the link. In contrast to VSAT dSCPC, the system only needs to close links that have a specified capacity. Because in dSCPC the terminal has its own carrier like SCPC.

The advantage of total link margin in dSCPC VSAT systems makes it possible to use more efficient modulation and FEC combinations.

TABLE VIII
MARGIN ADVANTAGE LINKS

Individual Terminal Utilization (%)	LM Util Factor (dB)
50%	3.0
25%	6.0
10%	10.0

If the VSAT IP system uses QPSK ¾ then the value of Es/No on the link is 6.23 dB, whereas in the VSAT dSCPC system with terminal network utilization of 50%, 25% and 10% can produce E_s/N_o of:

- 50 % utilization = 6.23 + 3 = 9.23 dB
- 25 % utilization = 6.23 + 6 = 12.23 dB
- 10 % utilization = 6.23 + 10 = 16.23 dB

Table IX displays the VSAT profit using the dSCPC method based on the percentage of terminal utilization on the link and the total link margin profit from VSAT IP based on the modulation index used when VSAT IP uses QPSK ¾ from Table.

TABLE IX
BENEFITS OF VSAT DSCPC LINK MARGIN

Utilization of terminals on the link	LM Util Factor (dB)	QPSK 3/4 required es/no (dB)	Total Link Margin VSAT dSCPC (dB)
50 %	3	6.23	9.23
25 %	6	6.23	12.23
10 %	10	6.23	16.23

So, the benefits from using the terminal on the system link and you can change the modulation used to adjust the Es/No value after using the terminal.

TABLE X
LINK MARGIN UTILIZATION OF VSAT DSCPC TERMINALS

Utilization of terminals on the link	Ice/No	Modulation Change
50 %	9.23 dB	8PSK 3/4
25 %	12.23 dB	16APSK 4/5
10 %	16.23 dB	32APSK 5/6

Table X shows that changing the Es/No value on the network can change the modulation used. Changes in modulation affect the allocated bandwidth. As the modulation index increases, the bandwidth used will become smaller so it can be used to increase carrier usage at other terminals. To find out the bandwidth used for each modulation index, calculations are carried out using Matlab simulation to display the relationship between bandwidth and the modulation index , as shown in Fig. 3.

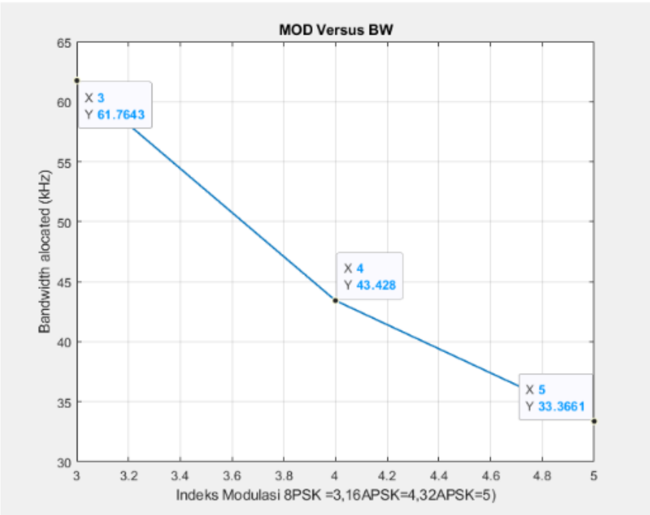

Figure 3. Relationship between modulation and bandwidth

The simulation results show that bandwidth usage decreases as the modulation index increases. For modcode 8PSK ¾, 16APSK 4/5, 32APSK 5/6 the bandwidth required on the carrier is 61.7643, 43.428, 33.3661 kHz. Next, you can find out the percentage of bandwidth usage towards the transponder bandwidth allocated for the Surabaya HUB return link.

- 8PSK ¾
  BW used = 61.763 kHz
  Available Satellite BW = 5100 kHz
  % Bandwidth Usage $=\left(\frac{Bandwidth\ Terpakai}{Bandwidth\ Tersedia}\right) \times 100\%$
  $=\left(\frac{61.763}{5100}\right) \times 100\% = 1.21\ \%$

- 16APSK 4/5
  BW used = 43.428 kHz
  Available Satellite BW = 5100 kHz
  % Bandwidth Usage $=\left(\frac{Bandwidth\ Terpakai}{Bandwidth\ Tersedia}\right) \times 100\%$
  $=\left(\frac{43.428}{5100}\right) \times 100\% = 0.85\ \%$

- 32APSK 5/6
  BW used = 33.3661 kHz
  Available Satellite BW = 5100 kHz
  % Bandwidth Usage $=\left(\frac{Bandwidth\ Terpakai}{Bandwidth\ Tersedia}\right) \times 100\%$
  $=\left(\frac{33.3661}{5100}\right) \times 100\% = 0.65\ \%$

Table XI shows that the bandwidth usage of a total of 5100 kHz for 32APSK modulation is 0.65%, 16APSK is 0.85% and 8PSK is 1.21%.

TABLE XI
BANDWIDTH USAGE

Parameter	8PSK 3/4	16APSK 4/5	32APSK 5/6
Bandwidth	61.7643 kHz	43.428 kHz	33.3661 kHz
Usage Percentage	1.21 %	0.85 %	0.65%

Modulation with 32APSK has less bandwidth usage than other modulations using the same bitrate value. So we get comparative data on bandwidth usage on VSAT IP and VSAT dSCPC after utilizing terminal usage on the transponder frequency slot. By using the same return link capacity, the bandwidth that can be allocated by VSAT dynamic Single Channel Per Carrier is around 1.21% to 0.65% less compared to VSAT IP which uses the TDMA access method.

IV. CONCLUSION

From the problem formulation it can produce measurements and analysis which can be concluded as follows: Implementation of VSAT using the dSCPC method on the return link is carried out by making rules on the slot frequency group containing the user's carrier terminal so that the network is maintained according to the user's bandwidth capacity reservation. The dSCPC method provides advantages on the bandwidth usage side, namely saving operational costs on the user side. And the configuration of the reserved VSAT dSCPC bandwidth does not have a fixed value, so that this network can maximize the use of link quality at each terminal. The results of the analysis showed that the results of calculating Es/No on the remote VSAT Colo Surabaya using the link budget method produced a total C/N value = 55.7 dB and Eb/No = 7.57 dB, while the results then produced a value of Es/No = 12,002 dB, while the measurement results Es/No gets an average value of 12.07 dB. The Es/No difference between measurements and calculations is approximately 0.068 dB. The difference in value is not too significant compared to the standard value for the Newtec modem, so it can be received with good quality. The bandwidth allocated by the system HUB on the Colo Surabaya remote VSAT is 66.8 KHz in 3 measurements with a bitrate of 132,352 Kbps. Using VSAT with the dSCPC method is more efficient than VSAT IP TDMA even though it uses the same parameters. The return link network with VSAT dSCPC reduces bandwidth usage on VSAT IP by 35% to 60%. With the same capacity, VSAT dSCPC has a better link margin.

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