OVERALL LINK ANALYSIS ON HRIT AND LRIT IN COMS

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ABSTRACT:

This paper describes link analysis on the processed data, HRIT (High Rate Information Transmission) and LRIT (Low Rate Information Transmission), for the preliminary design of interface between COMS (Communication, Ocean and Meteorological Satellite) and ground station. At the MODAC (Meteorological/Ocean Data Application Center), the processed data are transmitted to user station via COMS with normalization and calibration by pre-processing of MI (Meteorological Imager) data. Due to consider satellite as radio relay, overall analysis containing uplink and downlink is needed. Specific link parameters can be obtained with using the outcomes of SRR (System Requirement Review) which was held on 13-14 June 2005, in Toulouse. From the relation between overall link margin and output power of HPA (High Power Amplifier) of MODAC, it is shown that even though the minimum power related with COMS receiving power range is transmitted at MODAC, the obtained link margin of HRIT could be above 3 dB at user station which antenna elevation angle is 10 degree.

KEY WORDS: COMS, link, HRIT, LRIT, MODAC

1. INTRODUCTION

COMS launch is expected in 2008. It will be the first Korean geostationary satellite which has three main missions, i.e. satellite communication mission, ocean monitoring mission and meteorological mission. In the ground segment of the COMS, there will be the Meteorological/Ocean Data Application Center (MODAC) which will receive raw image data, generate calibrated image data as well as extracted products and distribute processed data (HRIT/LRIT) through the spacecraft. The spacecraft operation and monitoring will be performed at the Satellite Operation Center (SOC). The SOC will have also back-up function of the Data Processing Center (DPC) to provide against emergency situation of the primary DPC. The SOC and MODAC will be connected through exclusive lines for the data transmission. The Communication System Monitoring Center (CSMC) will monitor RF signals to check the status of Ka-Band communication system. Figure 1 shows the COMS system architecture.

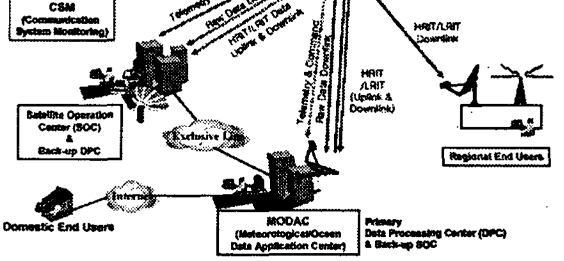

Figure 1. COMS System Architecture

Raw imagery taken from a geosynchronous orbit will be transmitted to the MODAC. At the MODAC, raw data will be calibrated geometrically and radiometrically and be converted to the processed data.

The certain part of processed meteorological data will be sent back to the spacecraft for the distribution of data to regional end users. The processed meteorological and ocean data will be distributed to domestic end users through existing ground networks.

This paper describes the link analysis of processed data for the preliminary design of interface between COMS and ground station. The goal of a link analysis is to determine whether or not the required error performance is met by examining the Eb/No (ratio of bit energy to noise power spectral density) actually received and comparing it with the Eb/No required meeting the system specification. The principal parameters needed for this determination are the EIRP (how much effective power is transmitted), the G/T (how much capability the receiver has for collecting this power), Ls (the largest single loss, namely the space loss) and Lo (other contributing losses and degradation). For more reliable analysis, all parameters, except the Ls and Lo are based on the outcomes of SRR which was held on 13-14 June 2005, in Toulouse. Especially, analysis is accomplished with the consideration about the satellite which can be defined non-regenerative repeater because it is just working without any reprocessing the receive data.

This paper is divided into three parts. In the first part, the process of link analysis about non-regenerative satellite is described. Then HRIT and LRIT overall link analysis is accomplished by specific parameter, and lastly, the link margin at user station is shown as increasing the transmitted EIRP at MODAC from 10 [W] to 200 [W]

2. NON-REGENRATIVE REPEATERS

Link analysis for a non-regenerative repeater treats the entire 'round trip' as a single analysis. Features that are unique to non-regenerative repeater are the dependence of the overall SNR (Signal to Noise Ratio) on the uplink SNR and the sharing of the repeater downlink power in proportion to the uplink power from each of the various uplink signals and noise.

Figure 2 illustrates the important link parameters of a satellite repeater channel. The repeater transmits all uplink signals without any processing beyond amplification and frequency translation.

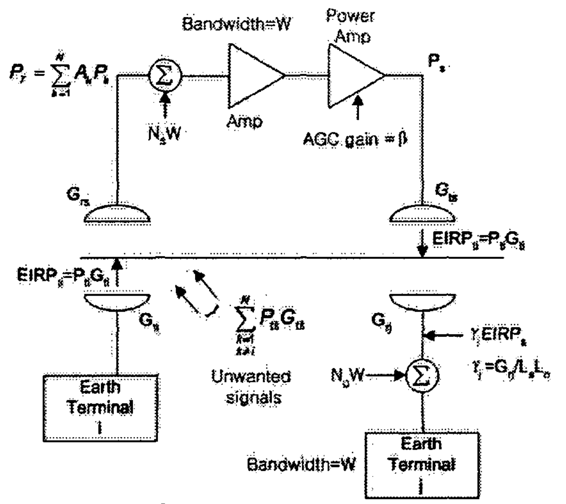

Figure 2. Non-regenerative satellite repeater

The transmission starts from a ground station, say terminal i, with a terminal $EIRP_{ti}=P_{ti}G_{ti}$. Simultaneously, unwanted signals are being transmitted to the satellite. At the satellite, a total signal power $P_T=\Sigma A_k P_k$ is received, where A_k reflects the uplink propagation loss and the satellite receive antenna gain. N_sW is the satellite uplink noise power, where N_s is the composite noise power spectral density due to noise radiated into the satellite antenna and generated in the satellite receiver. The total satellite downlink $EIRP_s=P_sG_{ts}$, where P_s is the satellite transponder output power and G_{ts} is the satellite transmitting antenna gain, can be expressed by the following identity. [1]

$$EIRP_s = EIRP_s \beta[A_i P_i + (P_T - A_i P_i) + N_s W] \quad (1)$$

Both the left and right sides of Equation (1) express the total satellite EIRP. On the right side, the term $\beta[A_i P_i + (P_T - A_i P_i) + N_s W]$ constitutes the fractional apportionment of $EIRP_s$ for the various signals and uplink noise, such that the composite express equals unity. The total power gain of the transponder can be expressed as βP_s. Since P_s is fixed and the input signals can vary, $\beta=1/(P_T+N_sW)$ represents an Automatic Gain Control (AGC) term. The total power received at the j earth terminal, with bandwidth W, can be written as

$$P_{rj} = EIRP_s \gamma_j \beta[A_i P_i + (P_T - A_i P_i) + N_s W] + N_g W \quad (2)$$

Where $\gamma_j=G_{rj}/L_sL_o$ account for downlink losses and receiving antenna gain for the j earth terminal and N_g is the downlink noise power spectral density generated and introduced into the terminal receiver. Equation (2) can be rewritten by replacing β with its equivalent $1/(P_T+N_sW)$ as follows

$$P_{rj} = EIRP_s \gamma_j \left(\frac{A_i P_i}{P_T + N_s W} + \frac{P_T - A_i P_i}{P_T + N_s W} + \frac{N_s W}{P_T + N_s W} \right) + N_g W \quad (3)$$

From Equation (3) the P_r/N for signal i received at the j terminal can be expressed as

$$\left(\frac{P_r}{N}\right)_{ij} \approx \frac{EIRP_s \gamma_i [A_i P_i / (P_T + N_s W)]}{EIRP_s \gamma_j [N_s W / (P_T + N_s W)] + N_g W} \quad (4)$$

An estimate of the performance described in Equation (4) can be obtained by using the uplink and downlink values of Eb/No, combined as follows, [2]

$$\left(\frac{E_b}{N_o}\right)^{-1}_{overall} = \left(\frac{E_b}{N_o}\right)^{-1}_{uplink} + \left(\frac{E_b}{N_o}\right)^{-1}_{downlink} \quad (5)$$

3. OVERALL LINK OF PROCESSED DATA

Table 1 summarizes the link parameters of processed data based on the outcomes of COMS SRR.

Table 1. The link parameters of processed data

Parameter	HRIT	LRIT
Data Rate [Mbps]	3	≤ 0.256
Modulation	QPSK	BPSK
Forward Error Correction	Viterbi, RS	Viterbi, RS
Bandwidth [MHz]	5.15	≤ 0.88
COMS G/T [dB/K]	11	11
COMS EIRP [dBW]	25.21	25.21
User Station G/T [dB/K]	10.207	0.485
Required BER	$> 10^{-8}$	$> 10^{-8}$
COMS Receiving Level	$-106 \sim -80$ dBW/m^2	

Orbit and up/down link frequency are not fixed yet, so we can't help considering a general value, namely slant rage is 35,768 Km and up/down link frequency is 2100/1710 MHz according to ITU-R.

From the COMS receiving level described in table 1, the available EIRP at MODAC is calculated as 56.43 ~ 82.43 [dBW] and output of HPA is estimated as 46 ~ 9000 [W] by considering Ls and Lo.

Considering 100 [W] as the output of HPA at MODAC, Table 2 shows that the link margin is above 3dB for HRIT and LRIT user station which antenna elevation angle is 10 degree.

Table 2. Overall link analysis on the processed data

Parameter	HRIT	LRIT	Units
Transmitter EIRP	60.88	60.88	dBW
Uplink Space Loss	190.139	190.159	dB
Received Signal Power	-119.973	-119.993	dBW
G/T	11	11	dB/k
Noise Spectral Density	-222.6	-222.6	dBW/Hz
System Bandwidth	6.2	1	MHz
Noise Power	-154.693	-162.373	dBW
Received Others	-1000	-1000	dBW
Other Signal + Noise	-154.693	-162.373	dBW
Total Received Power	-119.972	-119.993	dBW
S/N	34.72	42.38	dB
S/No	102.627	102.607	dBHz
Signal Power in EIRP	25.21	25.21	dBW
Other Signal in EIRP	-854.818	-854.797	dBW
Noise Power in EIRP	-9.512	-17.17	dBW
Downlink Space Loss	189.084	188.432	dB
Received Signal Power	-131.575	-141.358	dBW
Received U/L Noise	-165.872	-183.738	dBW
G/T	10.207	0.485	dB/K
Noise Spectral Density	-206.507	-206.545	dBW/Hz
System Bandwidth	6.2	1	MHz
Noise Power	-138.601	-146.317	dBW
U/L + D/L Noise Power	-138.593	-146.316	dBW
Overall S/No	74.924	65.187	dBHz
Implementation Loss	2	2	dB
Margin	3.531	4.442	dB

Figure 3 illustrates the variation of overall link margin when the output power of HPA increases from 10 [W] to 200[W] for 11 [dB/K] of COMS G/T.

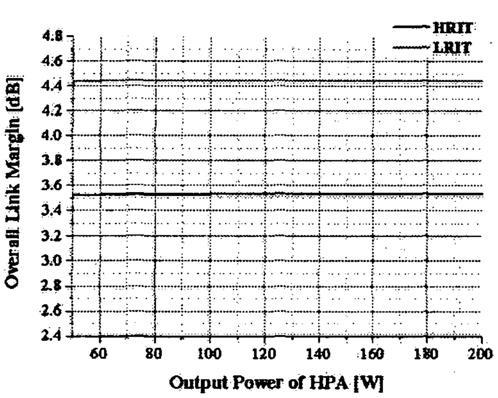

Figure 3. Overall link margin vs. output power of HPA

Despite of changing the output power of HPA, overall link margin shows nearly continuous value, HRIT is 3.5 [dB] and LRIT is 4.4 [dB]. Therefore, the reasonable output power of HPA is 50 [W] for each processed data in the case of 11 [dB/K] of COMS G/T, which is the minimum power in the receiving range of COMS.

Figure 4 shows the influence of COMS G/T on overall link margin by considering overall analysis under the condition of 50 [W] of HPA's output

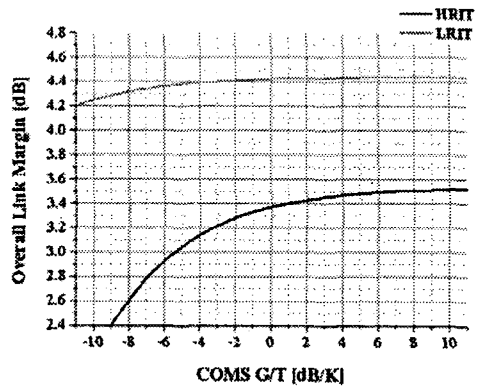

Figure 4. Overall link margin vs. COMS G/T

In the case of HRIT, the overall margin is nearly continuous for the 10 ~ 6 [dB/K] of G/T, but it becomes small and finally under 3 [dB] for -5 [dB/K] of COMS G/T. From figure 3 and 4, we can conclude that the link margin depends on not only the downlink part, the EIRP of satellite but also the uplink part, the output power of HPA on ground station and G/T of COMS.

4. CONCLUSION

This paper describes the link budget of processed data for the preliminary design of interface between COMS and ground station. Because of considering satellite as radio relay, overall analysis containing uplink and downlink is needed. Frome the output of overall analysis, the reasonable output power of HPA at MODAC is 50 [W] and this conclusion will be used to decide the specification of ground segment.

5. REFERENCE

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