Responses to Examiner 1

1. **There are no received signal models at relay and destination, including distributions of channel fading and noise. The reader needs to guess Equation (4.3) and (4.4) on page 59, including the meaning of N_0 and E_s(t).**

   Author's response: The author truly appreciates the concern of the examiner and as a matter of fact the revised dissertation has included channel models of the received signal at the relay and destination nodes in Chapter 4, section 4.2 from the second paragraph in page 57.

2. **No definition of alpha, P_s in Equ.(4.10);**

   Author's response: α in equation 4.12 of the revised dissertation (4.10 in the original version) is the energy harvesting efficiency but for purposes of reducing complexity of the analysis, it has been fixed and P_S is the transmit power of the source device (please refer to equation 4.1 in section 4.2 of Chapter 4 page 57).

3. **"Below" in the last paragraph on page 61 should use "Figure 4.3"**

   Author's response: The author really appreciates the examiner for pointing this out. In the revised dissertation the word "Below" has been replaced by "Fig. 4.3" in page 63.

4. **In Fig 4.3, it is not clear how to get the figure. Also it is kth relay energy quantization, but no k^{th} in the figure;**

   Author's response: The author is thankful again for the examiner for pointing this out. Fig. 4.3 simply paints a picture of energy evolutions of a single relay which are discrete multiples of the smallest energy E_0. It is meant to be a general energy evolution model for all relays that is why it is the K^{th} relay energy quantization. The harvested energy is built up in multiples of E_0. That is as one relay is chosen to transmit the other is harvesting and building up charge in the battery. This charge will be stored until the battery capacity has been reached and for purposes of reducing the complexity of analysis it has been assumed that a fixed energy of E_0 is stored for all transmit intervals. For example, a relay not chosen to transmit in two consecutive transmit intervals will only have E_0 in the first interval and 2E_0 in the second transmit interval.

5. **In Equ. (4.19) to (4.22) the reviewer did not find the variance of noise is 1.**

   Author's response: The author is thankful to the examiner for this insightful concern. The newly derived expressions for instantaneous signal-to-noise ratios between the source and the k^{th} relay (γ_{SR_k}), and the k^{th} relay and the destination (γ_{R_kD}) are given in terms of noise variance as opposed to the original dissertation. Please refer to equations 4.21, 4.22, 4.23 and 4.24 in subsection 4.3.1. page 68.

6. **On page 68, the minimum of y is 0, not negative infinite because y is SNR.**

   Author's response: As per the examiner's suggestion, the lower bound SNR of both the CDF and PDF equations on page 69 (as per the revised dissertation) have been corrected to 0.

7. **The reviewer doubt the PDF derivation on page 68. It seems that the candidate did not use Equ. (4.8) to derive the PDF. What is average γ_{R_1D}? Please check the derivations on page 68**

Author's response: The author thanks the examiner for raising this issue. Before proceeding with an appropriate response to the examiner's concern, it is worth pointing out that the derived PDF in page 68 is not for outage but for selection of a particular relay with a better SNR. Since the problem at hand is limited to only two relays then the selection of the best relay is achieved by computing the PDF of the difference of two exponential random SNR variables. The closed-form expression for the outage probability of decode-and-forward relaying for Rayleigh fading channels and other channels was derived in references [108]-[113]. $\bar{\gamma}_{R_1D}$ *is the average SNR between relay 1 (*R_1*) and the destination node (D). More practically, it is the expected value of a discrete random variable* γ_{R_1D}

It is also worth mentioning that the PDF derivation in page 69 (page 68 as per previous revision) follows the PDF in equation 4.7 (equation 4.5 as per the previous revision) which is the differential of the CDF in equation 4.10 (equation 4.8 as per the previous revision). In a simpler explanation the derivation of the relay selection PDF in 69 (page 68 as per previous revision) was reduced to its PDF equivalent which follows the integral of CDF in 4.10 (equation 4.8 as per the previous revision).

8. The exp function in (4.25) is negative, not positive.

Author's response: The author is thankful to the examiner for his/her careful review of a missing negative sign in equation 4.29 (equation 4.25 in the original version) in page 70. Its application is such that it is dependent on the value of z, for z<0 would mean relay 2 has a better SNR link whilst for z>0 would mean relay 1 has a better SNR link. The corrected equation is as shown below.

$$f_Z(z) = \begin{cases} \dfrac{\exp\left(-\dfrac{z}{\bar{\gamma}_{R_2D}}\right)}{\bar{\gamma}_{R_1D} + \bar{\gamma}_{R_2D}}, & if \quad \gamma_{R_1D} < \gamma_{R_2D} \\ \dfrac{\exp\left(-\dfrac{z}{\bar{\gamma}_{R_1D}}\right)}{\bar{\gamma}_{R_1D} + \bar{\gamma}_{R_2D}}, & if \quad \gamma_{R_1D} > \gamma_{R_2D} \end{cases}$$

9. The derivations of Equ.(4.36) to (4.37) are wrong.

Author's response: The author thanks the examiner for raising this issue. However, it has been verified that both equations 4.40 (4.36 as per the original version) and 4.41 (4.37 as per the original version) in page 74 are indeed correct as both are conditional outage equations. Equation 4.40 computes the system outage while the system is at state (i≠1, j=1) and on the other hand equation 4.41 computes outage while the system is at state (i=1, j≠1). Equation 4.40 is the conditional outage equation which is a function of energy of relay 1 and the expected value of the channel coefficient between relay 1 and the destination node. On the other hand equation 4.41 is the conditional outage equation which is a function of energy of relay 2 and the expectation of the channel coefficient between relay 2 and the destination node.

10. On page 73, need to add noise distribution in simulations. Since channel fading is complex, so change h^2 to $abs(h)^2$

Author's response: The author is thankful to the examiner for correction. It should also be noted that in all the simulations for both $\bar{\gamma}_{SR_k}$ *and* $\bar{\gamma}_{R_kD}$*, their channel gains are expressed as*

$|\overline{h}_{SR_k}|^2$ *and* $|\overline{h}_{R_kD}|^2$ *respectively. Please refer to the corrected equations of average SNRs in section 4.4 of numerical results and simulations page 75.*

11. On page 74, the simulation actually is worse than theory, not match, need to discuss this.

Author's response: The Monte Carlo simulations and the analytical results were re-ran again and found to match better than in the original revision. The newly attached results are still in figure 4.6 page 76 of the revised dissertation.

The approximation of the system simulation model becomes better as the number of iterations increases. The accuracy is expected to increase as the number of iterations increases. Although the Monte Carlo simulation is properly formulated, it is statistically true with some potential (solution) error proportional to $\frac{1}{\sqrt{I}}$ *for I being number of iterations. Therefore, any minor discrepancy on the simulation and analytical results is believed to be a resultant of not a very large number of iterations to make Monte Carlo simulations fit the analytical results.*

12. $\boldsymbol{\gamma_{SR}}$ **is not a vector in Equ.(5.1). The same as in Equ.(5.2). b_rx should be b_tx in Equ.(5.2);**

Author's response: $\boldsymbol{\gamma_{SR_k}}$ *and* $\boldsymbol{\gamma_{R_kD}}$ *in equations 5.1 and 5.2 respectively are not vectors but rather the maximum source and the k^th relay* (γ_{SR_k}) *link, and the maximum k^th relay and the destination* (γ_{R_kD}) *link. This is in line with the definitions in reference [12], [36], [37] and [67]. The author is also appreciative of the correction of* $\boldsymbol{b_{tx}}$ *in equation 5.6 of the revised dissertation (equation 5.2 of the original version).*

13. Based on (4.21) and (4.22) the derivations from (5.7) to (5.15) are all wrong.

Author's response: The author is thankful to the examiner for getting an opportunity to elaborate on the equations from 5.11 (5.7 in original) to 5.19 (5.15 in original). It is worth mentioning that the scheme used in chapter 5 is a hybrid scheme of opportunity relay selection (ORS) and Max-Max relay selection (MMRS). With this hybrid scheme, selection of the relay is done on the half-phases source-relay and relay-destination. Therefore, there will be system outage when either half-phase is in outage or both are in outage as shown in the revised dissertation by equations 5.15 (Relay 1, Relay 1), 5.16 (Relay 2, Relay 2), 5.17 (Relay 1, Relay 2) and 5.18 (Relay 2, Relay 1). Where (Relay 1, Relay 1), (Relay 2, Relay 2), (Relay 1, Relay 2) and (Relay 2, Relay 1) are distinct possible events. The probabilities of selecting relays to receive and transmit, and the outage probabilities are based on the signal model defined in equations 5.1 to 5.4. Hopefully, this explanation and the equations answer the examiners' concern that outage expressions in this chapter were wrong.