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Assignment 2

Due: Thursday, 16 June 2022, 11:55 PM

ZEIT8219 Satellite Communications

Assignment 2: Link Budget Analysis

ZEIT8219 2022 S1 Assignment 2 Marking Rubric.pdf 3 June 2022, 5:11 PM
ZEIT8219 2022 S1 Assignment 2.pdf 13 May 2022, 5:54 PM

Submission status

Submission status	Submitted for grading
	This assignment is not accepting submissions
Grading status	Released
Time remaining	Assignment was submitted 8 hours 31 mins early

Grading criteria

Q1 Link Budget	• All link budget fields are correct (values, units) • Clear, step-by-step working • Reasons for introducing relevant theory, equations, are explained and referenced ***20 points***	• All link budget fields are correct (values, units) • Clear, step-by-step working • Reasons for introducing relevant theory, equations, are explained and referenced ***18 points***	• Link budget fields have minimal errors • Clear step-by-step working, where shown • Equations and relevant theory are referenced, where applicable ***16 points***	• Link budget fields have minimal errors • Clear step-by-step working, where shown • Equations and relevant theory are referenced, where applicable ***14 points***	• Most link budget fields are correct • Clear step-by-step working, where shown • Most equations and relevant theory are referenced, where applicable ***12 points***	• Most link budget fields are correct • Clear step-by-step working, where shown • Most equations and relevant theory are referenced, where applicable ***10 points***	• Severa errors in budget f • Workin shown b some st are miss Equatior not all referenc theory m may not mention ***8 points***
Q1 Analysis	• All implications (Eb/N0, system parameters, other factors), are described • There is insightful discussion on each of the above implications • Analysis is clear and comprehensive • Reasoning is logical and fully described ***5 points***		• All implications (Eb/N0, system parameters, other factors), are described • There is general discussion on each of the above implications • Analysis is clear • Reasoning is logical with few omissions ***4 points***		• Most implications (Eb/N0, system parameters, other factors), are described • There is brief discussion on each of the above implications • Analysis is mostly clear • Reasoning is mostly logical but omits some key factors ***3 points***		• Only one or no implications (Eb parameters, oth are described • or no discussion above implicatio Analysis lacks c some areas • R not generally log ***2 points***
Q2 Power Calculations	• Correct C/N value provided in the answer • Clear and comprehensive step-by-step working • Reasons for introducing relevant theory, equations, are explained and referenced ***20 points***	• Correct C/N value provided in the answer • Clear and comprehensive step-by-step working • Reasons for introducing relevant theory, equations, are explained and referenced ***18 points***	• Correct C/N value provided in the answer, or minor error • Clear step-by-step working, where shown • Equations and relevant theory are referenced, where applicable ***16 points***	• Correct C/N value provided in the answer, or minor error • Clear step-by-step working, where shown • Equations and relevant theory are referenced, where applicable ***14 points***	• Correct C/N value provided in the answer, or minor error • Clear step-by-step working, where shown • Equations and relevant theory are referenced, where applicable ***12 points***	• Correct C/N value provided in the answer, or minor error • Clear step-by-step working, where shown • Equations and relevant theory are referenced, where applicable ***10 points***	• Error method leading incorre value • Workin shown, missing some s Equati are not referen theory or may be mentio ***8 poin***
Q2 Analysis	• All implications (values, sensitivities, considerations) are described • There is insightful discussion on each of the above implications • Analysis is clear and comprehensive • Reasoning is logical and fully described ***5 points***		• All implications (values, sensitivities, considerations) are described • There is general discussion on each of the above implications • Analysis is clear • Reasoning is logical with few omissions ***4 points***		• Most implications (values, sensitivities, considerations) are described • There is brief discussion on each of the above implications • Analysis is clear • Reasoning is mostly logical but omits some key factors ***3 points***		• Only one or no implications (val sensitivities, cor are described • discussion on e above implicatio Analysis lacks c some areas • R not generally log ***2 points***
Q3 Analysis of platform needs	• Platform needs are clearly described and substantiated. • All assumptions, including identifying an approximate data rate requirement,	• Platform needs are clearly described and substantiated. • All assumptions, including identifying an approximate data rate	• Platform needs clearly described and mostly substantiated • All assumptions, including identifying an approximate data rate requirement,	• Platform needs clearly described and mostly substantiated • All assumptions, including identifying an approximate data rate requirement,	• Platform needs described with some lapses in clarity or basis • Most assumptions, including identifying an approximate data rate	• Platform needs described with some lapses in clarity or basis • Most assumptions, including identifying an approximate data rate	• Platform needs described bu lack clarity o basis • Assumption are describe but explanation have gaps ***4 points***

	and other estimates are described and sensibly explained. ***10 points***	requirement, and other estimates are described and sensibly explained. ***9 points***	and other estimates are described and explained. ***8 points***	and other estimates are described and explained. ***7 points***	requirement, and other estimates are described and explained. ***6 points***	requirement, and other estimates are described and explained. ***5 points***	
Q3 Analysis of suitable terminal	• Terminal characteristics suit the chosen platform • Terminal performance accurately described • Terminal capabilities clearly analysed and explained ***5 points***		• Terminal characteristics suit the chosen platform • Terminal performance accurately described with few gaps • Terminal capabilities analysed and explained ***4 points***		• Terminal characteristics suit the chosen platform • Terminal performance described, with some gaps or inaccuracies • Terminal capabilities analysed and explained ***3 points***		• Terminal chara mostly suit the c platform • Descr terminal perform described but d clearly match lis characteristics c is questionable capabilities expl analysis lacks c detail ***2 points***
Q3 Analysis of constellation capabilitites and limitations	• Constellation capabilities are clearly described and substantiated. • Assumptions are tested, justified and feasible. ***10 points***	• Constellation capabilities are clearly described and substantiated. • Assumptions are tested, justified and feasible. ***9 points***	• Constellation capabilities are clearly described and substantiated. • Assumptions are justified and feasible. ***8 points***	• Constellation capabilities are clearly described and substantiated. • Assumptions are justified and feasible. ***7 points***	• Constellation capabilities are described and mostly substantiated. • Assumptions are mostly justified and feasible. ***6 points***	• Constellation capabilities are described and mostly substantiated. • Assumptions are mostly justified and feasible. ***5 points***	• Constell capabilitie are mostl described lack some substantia • Assump are partly justified a mostly feasible. ***4 points***
Q3 Analysis of fit to needs	• Constellation capabilities and limitations are robustly assessed for relevance to and effect on platform needs and limitations. • Insightful discussion of other aspects of the system that might affect performance ***10 points***	• Constellation capabilities and limitations are robustly assessed for relevance to and effect on platform needs and limitations. • Insightful discussion of other aspects of the system that might affect performance ***9 points***	• Constellation capabilities and limitations are assessed for effect on platform needs and limitations. • Other aspects of the system that might affect performance are assessed for relevance and impact. ***8 points***	• Constellation capabilities and limitations are assessed for effect on platform needs and limitations. • Other aspects of the system that might affect performance are assessed for relevance and impact. ***7 points***	• Constellation capabilities and limitations are assessed, but assessment misses some aspects of platform needs and limitations. • Other aspects of the system that might affect performance are assessed but not rigorously. ***6 points***	• Constellation capabilities and limitations are assessed, but assessment misses some aspects of platform needs and limitations. • Other aspects of the system that might affect performance are assessed but not rigorously. ***5 points***	• Constella capabiliti and limitation assessed assessm misses important aspects c platform needs an limitation Limited attempt w made at consideri other fact that affec system performa ***4 points***
Q3 Conclusion	• Arguments are made logically, with clear cause and effect relationships. • Conclusion is obvious and well supported by both quantitative and qualitative analysis.	• Arguments are made logically, with clear cause and effect relationships. • Conclusion is obvious and well supported by both quantitative and	• Arguments are made logically, with clear cause and effect relationships. • Conclusion is obvious and well supported by both quantitative and	• Arguments are made logically, with clear cause and effect relationships. • Conclusion is obvious and well supported by both quantitative and	• Arguments are made though with some logic flaws. • Conclusion is clear and supported by both quantitative and qualitative analysis, with	• Arguments are made though with some logic flaws. • Conclusion is clear and supported by both quantitative and qualitative analysis, with	• Argume are made are flawe Conclusi made but support is lacking. ***4 points***

	10 points	qualitative analysis. *9 points*	qualitative analysis. *8 points*	qualitative analysis. *7 points*	some gaps. *6 points*	some gaps. *5 points*
Q3 Use of sources and APA referencing	• Relevant & high-quality research. Referencing consistently accurate. *5 points*	• Mostly relevant, good-quality sources identified. Referencing consistently accurate. *4 points*	• Some relevant, good-quality sources identified. Only minor inaccuracies in referencing *3 points*	• Minimal releva quality sources Some inaccurac referencing. *2 points*		

Last modified	Thursday, 16 June 2022, 3:23 PM
File submissions	Z3531215_assmt2.zip 16 June 2022, 3:23 PM ZEIT8219_Assignment_2.pdf 16 June 2022, 3:23 PM
Submission comments	Comments (0)

Feedback

Grade

Q1 Link Budget	• All link budget fields are correct (values, units) • Clear, step-by-step working • Reasons for introducing relevant theory, equations, are explained and referenced ***20 points***	• All link budget fields are correct (values, units) • Clear, step-by-step working • Reasons for introducing relevant theory, equations, are explained and referenced ***18 points***	• Link budget fields have minimal errors • Clear step-by-step working, where shown • Equations and relevant theory are referenced, where applicable ***16 points***	• Link budget fields have minimal errors • Clear step-by-step working, where shown • Equations and relevant theory are referenced, where applicable ***14 points***	• Most link budget fields are correct • Clear step-by-step working, where shown • Most equations and relevant theory are referenced, where applicable ***12 points***	• Most link budget fields are correct • Clear step-by-step working, where shown • Most equations and relevant theory are referenced, where applicable ***10 points***	• Several errors in link budget fields • Working is shown but some steps are missing • Equations are not all referenced, theory may or may not be mentioned ***8 points***	• S err buc • W sho sor are Equ not refe the ma me ***6 p***
Q1 Analysis	• All implications (Eb/N0, system parameters, other factors), are described • There is insightful discussion on each of the above implications • Analysis is clear and comprehensive • Reasoning is logical and fully described ***5 points***		• All implications (Eb/N0, system parameters, other factors), are described • There is general discussion on each of the above implications • Analysis is clear • Reasoning is logical with few omissions ***4 points***		• Most implications (Eb/N0, system parameters, other factors), are described • There is brief discussion on each of the above implications • Analysis is mostly clear • Reasoning is mostly logical but omits some key factors ***3 points***		• Only one or none of th implications (Eb/N0, system parameters, oth factors) are described • There is little or no discussion on the above implications • Analysis lacks clarity in some are • Reasoning is not generally logical ***2 points***	
Q2 Power Calculations	• Correct C/N value provided in the answer • Clear and comprehensive step-by-step working • Reasons for introducing relevant theory, equations, are explained and referenced ***20 points***	• Correct C/N value provided in the answer • Clear and comprehensive step-by-step working • Reasons for introducing relevant theory, equations, are explained and referenced ***18 points***	• Correct C/N value provided in the answer, or minor error • Clear step-by-step working, where shown • Equations and relevant theory are referenced, where applicable ***16 points***	• Correct C/N value provided in the answer, or minor error • Clear step-by-step working, where shown • Equations and relevant theory are referenced, where applicable ***14 points***	• Correct C/N value provided in the answer, or minor error • Clear step-by-step working, where shown • Equations and relevant theory are referenced, where applicable ***12 points***	• Correct C/N value provided in the answer, or minor error • Clear step-by-step working, where shown • Equations and relevant theory are referenced, where applicable ***10 points***	• Error in methods leading to incorrect C/N value • Working is shown, missing some steps • Equations are not all referenced, theory may or may not be mentioned ***8 points***	• E me lea inc val Wo sh mi so Eq are ref the or be me ***6 p***
Q2 Analysis	• All implications (values, sensitivities, considerations) are described • There is insightful discussion on each of the above implications • Analysis is clear and comprehensive • Reasoning is logical and fully described ***5 points***		• All implications (values, sensitivities, considerations) are described • There is general discussion on each of the above implications • Analysis is clear • Reasoning is logical with few omissions ***4 points***		• Most implications (values, sensitivities, considerations) are described • There is brief discussion on each of the above implications • Analysis is clear • Reasoning is mostly logical but omits some key factors ***3 points***		• Only one or none of th implications (values, sensitivities, considerations) are described • There is no discussion on each of th above implications • Analysis lacks clarity in some areas • Reasonin not generally logical ***2 points***	
Q3 Analysis of platform needs	• Platform needs are clearly described and substantiated. • All assumptions, including identifying an approximate	• Platform needs are clearly described and substantiated. • All assumptions, including identifying an approximate	• Platform needs clearly described and mostly substantiated • All assumptions, including identifying an approximate data rate	• Platform needs clearly described and mostly substantiated • All assumptions, including identifying an approximate data rate	• Platform needs described with some lapses in clarity or basis • Most assumptions, including identifying an	• Platform needs described with some lapses in clarity or basis • Most assumptions, including identifying an	• Platform needs described but lack clarity or basis • Assumptions are described but explanations	• Platfo needs descrit but lac clarity basis • Assum are descrit but explan

		data rate requirement, and other estimates are described and sensibly explained.	data rate requirement, and other estimates are described and sensibly explained.	requirement, and other estimates are described and explained.	requirement, and other estimates are described and explained.	approximate data rate requirement, and other estimates are described and explained.	approximate data rate requirement, and other estimates are described and explained.	have gaps	have g
85.00 / 100.00		***10 points***	***9 points***	***8 points***	***7 points***	***6 points***	***5 points***	***4 points***	***3 poi***
		• Terminal characteristics suit the chosen platform • Terminal performance accurately described • Terminal capabilities clearly analysed and explained	• Terminal characteristics suit the chosen platform • Terminal performance accurately described with few gaps • Terminal capabilities analysed and explained	• Terminal characteristics suit the chosen platform • Terminal performance described, with some gaps or inaccuracies • Terminal capabilities analysed and explained				• Terminal characteristic mostly suit the chosen platform • Description o terminal performance is described but does not clearly match listed characteristics or feasib is questionable • Termin capabilities explained b analysis lacks clarity or detail	
		5 points	***4 points***	***3 points***				***2 points***	
Q3 Analysis of constellation capabilitites and limitations		• Constellation capabilities are clearly described and substantiated. • Assumptions are tested, justified and feasible.	• Constellation capabilities are clearly described and substantiated. • Assumptions are tested, justified and feasible.	• Constellation capabilities are clearly described and substantiated. • Assumptions are justified and feasible.	• Constellation capabilities are clearly described and substantiated. • Assumptions are justified and feasible.	• Constellation capabilities are described and mostly substantiated. • Assumptions are mostly justified and feasible.	• Constellation capabilities are described and mostly substantiated. • Assumptions are mostly justified and feasible.	• Constellation capabilities are mostly described but lack some substantiation. • Assumptions are partly justified and mostly feasible.	• C ca ar de la su • A ar ju m fe
		10 points	***9 points***	***8 points***	***7 points***	***6 points***	***5 points***	***4 points***	***3***
Q3 Analysis of fit to needs		• Constellation capabilities and limitations are robustly assessed for relevance to and effect on platform needs and limitations. • Insightful discussion of other aspects of the system that might affect performance	• Constellation capabilities and limitations are robustly assessed for relevance to and effect on platform needs and limitations. • Insightful discussion of other aspects of the system that might affect performance	• Constellation capabilities and limitations are assessed for effect on platform needs and limitations. • Other aspects of the system that might affect performance are assessed for relevance and impact.	• Constellation capabilities and limitations are assessed for effect on platform needs and limitations. • Other aspects of the system that might affect performance are assessed for relevance and impact.	• Constellation capabilities and limitations are assessed, but assessment misses some aspects of platform needs and limitations. • Other aspects of the system that might affect performance are assessed but not rigorously.	• Constellation capabilities and limitations are assessed, but assessment misses some aspects of platform needs and limitations. • Other aspects of the system that might affect performance are assessed but not rigorously.	• Constellation capabilities and limitations are assessed, but assessment misses important aspects of platform needs and limitations. • Limited attempt was made at considering other factors that affect system performance.	• Co ca an lim as as mi im as pla ne lim Lin att ma co oth tha sy pe
		10 points	***9 points***	***8 points***	***7 points***	***6 points***	***5 points***	***4 points***	***3 p***
Q3 Conclusion		• Arguments are made logically, with clear cause and effect relationships. • Conclusion is obvious and well supported by	• Arguments are made logically, with clear cause and effect relationships. • Conclusion is obvious and well supported by	• Arguments are made logically, with clear cause and effect relationships. • Conclusion is obvious and well supported by	• Arguments are made logically, with clear cause and effect relationships. • Conclusion is obvious and well supported by	• Arguments are made though with some logic flaws. • Conclusion is clear and supported by both quantitative	• Arguments are made though with some logic flaws. • Conclusion is clear and supported by both quantitative	• Arguments are made but are flawed. • Conclusion is made but support is lacking.	• A are are Co ma su lac
								4 points	***3 p***

	both quantitative and qualitative analysis. ***10 points***	both quantitative and qualitative analysis. ***9 points***	both quantitative and qualitative analysis. ***8 points***	both quantitative and qualitative analysis. ***7 points***	and qualitative analysis, with some gaps. ***6 points***	and qualitative analysis, with some gaps. ***5 points***
Q3 Use of sources and APA referencing	• Relevant & high-quality research. Referencing consistently accurate. ***5 points***	• Mostly relevant, good-quality sources identified. Referencing consistently accurate. ***4 points***	• Some relevant, good-quality sources identified. Only minor inaccuracies in referencing ***3 points***	• Minimal relevant, good quality sources identifie Some inaccuracies in referencing. ***2 points***		

Feedback comments

Q1 Link Budget Calculation (20%) - 0.7

- This question requires two pairs of satellite links to be analysed for two Earth Stations.
  - It was assumed that the Sub-Satellite Stations mentioned in Tables 2-5 onwards refer to the Mobile Earth Stations A and B listed in Table 1
  - The first satellite link pair is:
    - Earth Station A Upstream (Earth Station A to Fixed Station via Satellite) - Given answer in Table 2
      - Uplink (Earth Station A transmitting, Fixed Station receiving)
      - Downlink (Earth Station A receiving, Fixed Station transmitting)
    - Earth Station A Downstream (Fixed Station to Earth Station A via Satellite) - Given answer in Table 3
      - Uplink (Fixed Station transmitting, Earth Station A receiving)
      - Downlink (Fixed Station receiving, Earth Station A transmitting) directions
  - The second satellite link pair is (Earth Station B to Fixed Station via Satellite):
    - Earth Station B Upstream (Earth Station B to Fixed Station via Satellite) - Given answer in Table 4
      - Uplink (Earth Station B transmitting, Fixed Station receiving)
      - Downlink (Earth Station B receiving, Fixed Station transmitting)
    - Earth Station B Downstream (Fixed Station to Earth Station B via Satellite) - Given answer in Table 5
      - Uplink (Fixed Station transmitting, Earth Station B receiving)
      - Downlink (Fixed Station receiving, Earth Station B transmitting) directions
- Link budget calculation steps are present only via code, digging required to guess which calculations translated to which fields in the table - it helps to 1. explicitly reference equations in the text so that it is easier to see where calculations go wrong (though Table 16 helped some) and 2. present the link budget calculations in logical order of deduction, so that more marks can be awarded.
- Calculation inaccuracies were present, possibly by the use of python types. For single-step calculations, e.g. Calculating wavelength from frequency, differences are introduced at about 2 decimal places. No marks deducted for these small errors.
- Other errors were unable to be explained, refer to returned C/N0 and Eb/N0 values - errors underlined were in the downlink directions?

	Earth Station A UPSTREAM				Earth Station A DOWNSTREAM				Earth Station B UPSTREAM				Earth Station B DOWNSTREAM			
	Uplink (Expected)	Uplink (Given)	Downlink (Expected)	Downlink (Given)	Uplink (Expected)	Uplink (Given)	Downlink (Expected)	Downlink (Given)	Uplink (Expected)	Uplink (Given)	Downlink (Expected)	Downlink (Given)	Uplink (Expected)	Uplink (Given)	Downlink (Expected)	Downlink (Given)
C/N0 (dB)	94.03	94.539	113.77	116.277	123.04	123.548	93.59	94.598	93.90	94.405	113.77	116.277	123.04	123.548	91.24	92.246
Eb/N0 (dB)	13.41	13.917	33.15	35.656	42.42	42.927	12.97	13.977	13.28	13.783	33.15	35.656	42.42	42.927	10.62	11.624

- Some values, such as the value for Slant range (km) and Antenna efficiency are missing from the link budget calculation in the report.
- Other values, such as Transmitter/Receiver efficiency, were not explicitly included in the link budget calculation table as components of the uplink or downlink calculations - efficiency figures are only mentioned in 1.0, 1.2, 1.3 broadly as antenna properties.
- Some calculated parameters, such as transmitter noise temperature, did not need to be calculated. The fields that are listed in the table in the Submission section are required. No marks deducted.
- Other parameters, such as Transmitter Modulation Bandwidth and Receiver Modulation Bandwidth, can just be referred to and presented as RF Bandwidth (Hz). No marks deducted.
- There were fields such as Transmitter Modulation Roll-off factor and Receiver Modulation roll-off factor. Filter roll-off factor only refers to the satellite, and roll-off factor does not always apply on both Receiver and Transmitter sides. No marks deducted - for information only.

Q1 Analysis (5%) - 0.8

- The analysis hints at the fact that the antenna configuration is affected by the antenna area via the antenna diameter.
- It is antenna size that is the largest factor. Having a higher transmit power only strengthens performance in one direction.
- Other considerations expected in this discussion; size, weight, mobility, setup time.

Q2 Calculation (20%) - 0.6

- The calculations for uncoded C/N ratio, Coded C/N ratio, uncoded Eb/N0 ratio, coded Eb/N0 and BER seem off.

For the stated parameters, the maximum bit rate for the channel is 115.4 Mbps. Applying coding to this at the rates of 7/8, 3/4 and 1/2 gives data rates of 100.1, 86.5 and 57.7 Mbps, respectively. 1/2 rate coding gives insufficient data rate and can be discarded. Since we want the minimum C/N, we can focus on the rate that gives the greatest coding gain (3/4 rate), as that will allow the lowest carrier power.

Using either eqn 6-59 or Fig 2 in the Notes Addendum - Channel Coding, a BER of 10^-9 requires an Eb/N0 of 16 dB (16.03 if you use the eqn) for 8-PSK. This is the overall, coded Eb/N0 for the link. Subtracting the coding gain gives 13.03dB overall uncoded Eb/N0.

Using the specified uplink Eb/N0 you can seperate out the downlink Eb/N0 as 20.26 linear or 13.07 dB. Since C/N=Eb/N0 * r_b/B, the minimum C/N is then 16.7 dB

Q2 Analysis (5%) - 1

- The correct coding rate of 3/4 was selected, and explained.
- Good analysis on error sources vs data rates.

Q3 Analysis of Platform Needs (10%) - 1

- Platform needs are described in terms of required data rate and throughput. Good.
- Platform needs based on similar technology - GlobalHawk.

Q3 Analysis of suitable terminal (5%) - 1

- ThinAir terminal selected based on existing literature demonstrating BYOS control of chosen platform from selected terminal. Other factors, such as atmospheric attenuation were considered. Good.

Q3 Analysis of constellation capabilities and limitations (10%) - 1

- Constellation limitations are described, in 3.2.2.1 data throughput and frequency bands are discussed, good.
- Strong quantitative analysis, having two studies for low-altitude and high-altitude operations is appropriate.

Q3 Analysis of fit to needs (10%) - 1

- Assumptions are stated clearly.

Q3 Conclusion (10%) - 1

- Conclusion is sensible and well-supported by quantitative analysis in 3.3.2 and 3.3.3.