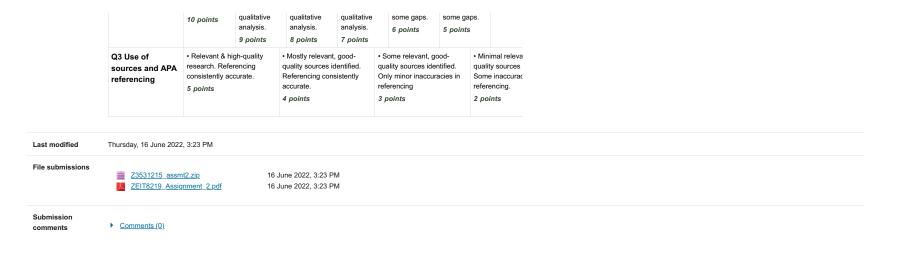


Grading criteria

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		minimal errors Clear step- by-step working, where shown Equations and relevant theory are referenced, where		Link budge fields have minimal erro Clear step-by-step working, where show 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		step wor where si • Most dequation relevant theory a referenc where applicab 10 poin		shown b some ste are miss	
Q1 Analysis	system paramel factors), are des There is insight discussion on e above implicatio Analysis is clear comprehensive	rstem parameters, other ctors), are described • nere is insightful scussion on each of the sove implications • nalysis is clear and omprehensive • Reasoning logical and fully described			Eb/N0, rs, other ribed • liscussi ove lysis is is logics	ion	syste facto Ther each impli most most	st implications on parameter ors), are descree is brief discree is brief discree of the above cations • Analtly clear • Realtly logical but e key factors ints	rs, oth ribed ussic lysis isonii	her on on is ng is	paramate or not above Analysome not g	Only one or no mplications (Eb parameters, other described or no discussion above implication analysis lacks come areas • Rinot 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 provide in the answere Clear and comprehens step-by-step working Reasons for introducing relevant theory, equations, an explained an referenced 18 points	value provided in the answer, o minor error • Clear step-by step working, where shown • Equations and relevant theory are referenced,		value provided ir the answer minor error Clear step- step workir		the answer minor error clear step- phy- king, own where showns Equations and relevan theory are referenced where e pplicable		the and minor of the series where series and return theory		swer, of error • step-by orking shown tions evant are aced,	method leading incorre value • Workin shown, missing some s	
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, consideration are described • There is general discussion on eac of the above implications • Analysis is clear • Reasoning is logical with few omissions 4 points			sens are of brief the a Anal Reas but of	ust implications (values, sitivities, considerations) described • There is discussion on each of above implications • lysis is clear • soning is mostly logical omits some key factors opints			• Only one or no implications (val sensitivities, cor are described • discussion on eabove implicatic Analysis lacks c some areas • Renot generally log 2 points		
Q3 Analysis of platform needs	Platform needs are clearly described and substantiated. All assumptions, including including approximate data rate requirement,	Platform needs are clearly described and substantiated. All assumptions, including identifying an approximate data rate		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 requirement,		described with some d lapses in clarity or s, basis • Most assumptions, including identifying an approximate		Platform needs described with some lapses in clarity or basis • Mos assumption including identifying approximated data rate		n d la b A A st as, b e an h	Platform eeds escribed by ack clarity c asis • assumptions re describe ut xplanations ave gaps points	

Q3 Analysis of suitable terminal	and other estimates are described and sensibly explained. 10 points • Terminal chars suit the chosen Terminal perfor accurately described analysed and establishments.	platform • mance ribed • ilities clearly	and other estimates are described and explained. 8 points • Terminal charasuit the chosen preminal perform accurately described apply accurately described apply in the capabilities analy explained 4 points	olatform • nance libed with nal	• To sui Ter des or i cap exp	requirement, and other estimates are described and explained. 6 points erminal charact it the chosen plarminal performa scribed, with so inaccuracies • 1 pabilities analys plained points	atform • nce me gaps erminal	Termost platfor term describer character is quicaparate.	
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		Constellatic capabilities are clearly described a substantial . Assumption are justified and feasible 7 points	and ed.	Constellation capabilities are described and mostly substantiated. Assumptions are mostly justified and feasible. 6 points	Constella capabiliti are desc and mos substant Assumpt are most justified a feasible.	es ribed tly iated. ions ly and	Constell capabilitie are mostly described lack some substantia Assump are partly justified a mostly feasible. A 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	assessed for effect on platform needs and limitations. • Other aspects of the system that might affect performance	Constellatic and limitations assessed to effect on platform needs and limitations. Other aspect of the syst that might affect performan are assess for relevan and impac 7 points	are for ects em	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	assesse assessm misses s aspects platform needs ar limitation	is are dd, but the ent some of and as. • stem and asset with the ent seed of t	Constella capabilitis and limitation: assessed assessed assesses important aspects oplatform 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	Argumen are made logically, we clear causs and effect relationship is conclusic is obvious and well supported both quantitative and	rith e ps. on by	Arguments are made though with some logic flaws. Conclusion is clear and supported by both quantitative and qualitative analysis, with	Arguma are mad though v some log flaws. Conclusic clear and supported both quantitat and qualitativa analysis.	e vith gic ion is d ed by tive	Argume are made are flawe Conclusic made but support is lacking. A points

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Feedback

Grade

Q1 Link Budget	are correct (values, units) • Clear, step-by-step working • Reasons for introducing relevant theory, equations,	et fields budget fields are correct (values, o'clear, units) • Clear, step-by-step go working • Reasons for ucing ant relevant theory, equations, xplained and referenced		ink budget dis have nimal rors • Clear ep-by-step prking, here shown equations d relevant aproperties of referenced, here plicable a points	Link budge fields have minimal errors • Clea step-by-step working, where shown • Equations and relevant theory are referenced, where applicable 14 points		budget fields are correct • Clear step- by-step working, m where shown • Most		Most lini audget fie are correct Clear step y-step vorking, where she Most equations and releva- neory are eference where ppplicable	bids errors in link the budget fields budget fields tworking is shown but some steps are missing Equations a not all referenced, theory may, may not be mentioned 8 points		ss I	• Si error buc • W sho ssor are Equanot refe the ma
Q1 Analysis	All implication system params factors), are de There is insigh discussion on a above implication above implication and analysis is clear comprehensive Reasoning is lefully described 5 points.	eters, other escribed • tful each of the ions • ar and	factor Ther discusabov Anal Reas	implications em paramet ors), are des re is general ussion on ea ve implicatio lysis is clear soning is log omissions oints	ers, other cribed • ach of the ns •	sys fact The on imp mod mod son	tost implication tem parametrors), are designere is brief diseach of the allolications • An stly clear • Restly logical bune key factors	ers, crib scus bov alys easo it or	other ped • ssion re sis is oning is mits	implicion syste factor There discu implicion lacks	clarity in so soning is no rally logical	N0, ers, ers, eribe no e ab alys eme	oth d • ov∈ is
Q2 Power Calculations	Correct C/N value provided in the answer to Clear and comprehensive step-by-step working Reasons for introducing relevant theory, equations, are explained and referenced 20 points	in the answ Clear and	ded er • sive p	Correct C/value provided in the answer, or minor error • Clean step-by-step working, where show • Equations and relevan theory are referenced, where applicable 116 points	value provide the ans or minor error • 0 step-by working where s	d in wer, r Clear -step l, showr ions evant are ced,	value provided in the answer, or minor ear error • Clear step step-by-step working, nown • Equations and relevant theory are theory are e applicable		Correct value provided the answor minor error • C step-by-working, where si • Equation and reference where applicable 10 points.	d in ver, clear step hown ons vant re eed,	• Error in methods leading to incorrect C value • Working is shown, missing some step Equations are not all referenced theory may or may not be mentioned 8 points	s•	• E me lea inc val Wc shi mi: soi Eq are ref the or be me 6 /
Q2 Analysis	sensitivities, considerations described • The insightful discu- each of the abo- implications • A clear and comp	rensitivities, considerations) are lescribed • There is a sightful discussion on each of the above mplications • Analysis is lear and comprehensive • Reasoning is logical and ully described		implications sitivities, siderations) in cribed • There and discussion of the abovications • Arr • Reasonin few omission bints	are re is on on re allysis is g is logica	(val con des disc abo Ana I Rea but	Most implications (values, sensitivitie considerations) are described. There discussion on each above implications Analysis is clear. Reasoning is most out omits some ke 3 points		s brief of the	Only one or none implications (values sensitivities, considerations) are described • There is discussion on each above implications. Analysis lacks clarif some areas • Reas not generally logica points		ire e is ch c ns • arity asoi	no of th
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 all approximate	ne de and sul d. • A assis, indicate an app	seds clearly secribed and mostly obstantiated All sumptions, cluding entifying an oproximate	described and mostl substantia • All	arly r	needs not described divith some was lapses in clarity or basis • Most assumptions, as including in		elatform eds scribed th some oses in crity or sis • Mos sumption cluding entifying	ne de bu cla ba st As ar, ar de bu	eeds escribed at lack earity or esis • escumptions e escribed	• Pli nee des but clar bas Ass are des but exp	ds crit lac ity is • um

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		and other	and other	estimates			requirement,		
		estimates are described	estimates are described				and other estimates		
		and sensibly	and sensibly	and			are		
	85.00 / 100.00	explained.	explained.	explained.			described		
	Anadomic lateratus Diferent Content 0 Con	10 points	9 points		1 points		and explained.		
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		are tested,	are tested,	are justified	are justified	justified and	justified and	mostly	mı
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	Q3 Analysis of fit	•	•	•	•	•	•	•	•
	to needs	Constellation	Constellation		Constellation	Constellation	Constellation		
		capabilities and	capabilities and	capabilities and	capabilities and	capabilities and	capabilities and	capabilities and	cal
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		relevance to	relevance to	platform	platform	misses some			mis
		and effect on platform	and effect on platform	needs and limitations. •	needs and limitations. •	aspects of platform	aspects of platform	important aspects of	im _l
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		Insightful	Insightful	the system	the system	Other	Other	limitations. •	lim
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		other aspects of the system			affect performance	the system that might	the system	attempt was made at	atti ma
		that might	that might	performance are assessed		affect	that might affect	considering	COI
		affect	affect	for relevance		performance	performance		oth
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		10 points	9 points	8 points	7 points	but not	but not	system	sys
						rigorously.	rigorously.	performance.	
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	Q3 Conclusion	Arguments		Arguments		Arguments		Arguments	
		are made	are made	are made	are made	are made	are made	are made but	
		logically, with clear cause	logically, with clear cause	logically, with clear cause	logically, with clear cause	though with some logic	though with some logic	are flawed. • Conclusion is	
		and effect	and effect	and effect	and effect	flaws. •	flaws. •	made but	ma
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		Conclusion	Conclusion		Conclusion	clear and	clear and	lacking.	lac
		is obvious	is obvious	is obvious	is obvious		supported by	y 4 points	3 1
		and well supported by	and well supported by	and well supported by	and well supported by	both quantitative	both quantitative		

	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 qualitativ analysis some ga 5 points	, with
Q3 Use of sources and APA referencing	Relevant & h research. Refe consistently ac points	erencing ecurate.	Mostly relevan quality sources Referencing cor accurate. Points	dentified.	qua On ref	some relevant, gality sources idealy minor inaccurerencing	entified.	Minimal relevant, good quality sources identifie Some inaccuracies in referencing. 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.
- o 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
- o 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?

0	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/N (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/N (dB)	13.41 0	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.