

University of Arkansas Microelectronics-Photonics Graduate Program
Ph.D. Candidacy Exam – March 14, 2003
Photonics Area of Emphasis Exam

I) BACKGROUND:

Laser communications is an alternative to radio frequency (RF) communication for high-speed intersatellite links. Intersatellite links are satellite-to-satellite communication and high-speed is defined as at least 10 Megabits per second (Mbps). Assume that this laser communication technology can be used in a satellite system operating in either a geosynchronous or low-earth orbit.

Your job, as chief engineer of the new company, is to design a laser communications system for intersatellite links and to come up with the one right product approach that will allow you and your partners to sell the company off in five years, leaving you to sip pina coladas while sailing your yacht around the world. But before you order your yacht, there is a lot of work to be done.

You must address all pertinent aspects of the photonic behavior of this device. This should include acquisition, tracking, types of lasers, wavelengths, filtering, transmitting power, receiving power, noise levels, etc. It will be up to you to both identify and address the technical issues that are vital to the unit's success as a marketable product.

II) SCIENCE BASIS AND PROPOSED SOLUTION: (Science emphasis)

A. Establish the Science basis

In this first part, examine and report on the current science of the use of laser communications for intersatellite links. Begin with a general discussion of the system but also describe in detail the theoretical aspects of the system and each of its components. Describe current state-of-the-art making use of diverse resources such as science literature, journals, patents or other sources of existing public knowledge. Be sure to cite all references used. Demonstrate an up-front understanding of the science limits behind the technology, making rigorous theoretical arguments leading to a proposed solution.

B. Compare and Contrast

Compare and contrast the laser communications with RF or other types of communications for intersatellite links. List the advantages and disadvantages of each and propose solutions for improving the existing technology. Provide details on the figure of merits used to compare the systems. One of the products should then be selected on the basis of criteria you define, defended logically, and a research/development plan should be proposed to fully develop the product.

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C. System

Elaborate on the selected photonic solutions, defend it logically, and propose a research plan to test the solution. Include at least one diagram of the system being proposed. Cite references that provide similar systems to the one proposed. Although a literature review is required and expected, some originality is expected when designing the system.

III) DEMONSTRATION OF A NEW PLATFORM: (Entrepreneurial engineering emphasis)

In this section, you should demonstrate your understanding of how the technical issues interplay with the business, marketing, manufacturing and economic issues involved in launching a new product.

You should perform a cost analysis from front end to back end - that is, from acquisition of raw materials, labor rates, costs per operation, etc. assuming quantities of 10 parts per year. You may exclude from your analysis possible additional costs in such infrastructure areas as human resources, facilities engineering, janitorial and grounds, upper level management, etc. You must include all direct manufacturing costs, both startup and continuing; and you must discuss explicitly space and personnel requirements to set up a stand-alone product line. Generic per process costs for various manufacturing methods can be used, as long as they are rationally applied.

In short, tell us everything that needs to happen to make your company, and the product you have chosen to develop, a roaring success. Make sure the logic you employ comes through in your writing, which should be carefully proofread. You will have to make lots of assumptions given the vague nature of the problem definition; this is OK as long as you state what those assumptions are and why you made them. Real life is a lot like that.

A. Prototype

Provide a detailed quantitative model resulting in specifications of performance of the system. This should include transmitter power, detection power, link parameters, channel parameters, optical noise, bit error rates, etc. Discuss the steps necessary to package the system for commercialization. Define specific reliability testing that will be completed prior to market introduction, along with the justification for each test.

B. Intellectual property

List all IP sources that were consulted while formulating the answer, and include the full list of examined documents as an appendix to this exam. (The full list will not be counted as part of the 15-page limit.)

C. Marketing analysis

Discuss the business, marketing, manufacturing and economic issues involved in launching a serious investigation of the proposed solution. Sources of available components and the cost should be listed. Identify potential customers of this system and how the technology will be applied. Estimate the number of customers and the number of systems that will be sold.

D. Broader impacts, future directions or new markets where concepts can be easily applied

In one or two paragraphs, discuss the impact and benefit to society and how to broaden the impact and to disseminate information as the research proves to be successful. Finally, you should make recommendations on future directions for investigation.