A Framework for Defining Graduate Telecommunications Education

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Abstract

Telecommunication programs in academic institutions across the country combine a diverse set of disciplines to provide a unified learning platform for the students and professionals in the large and highly dynamic telecom industry. The inter-disciplinary nature of the field provides a lot of flexibility to the programs in the creation of their goals and the development of their curricula. However, this flexibility makes it sometimes difficult for an observer to identify the similarities in the content across the range of telecom programs, and the set of skills they provide to their graduates. Based on our analysis of a subset of telecom programs, we argue that it is possible to define the common core of telecom education; paving the way for future standardization and better understanding of this discipline. Finally, this paper proposes a framework for the identification of such common core and provides a basic set of the same based on our study.

1. Introduction

Telecom programs have been popular for more than two decades, and are represented in dozens of universities and colleges both in the US and abroad. They bring together a diverse set of skills from traditionally disjoint disciplines, and couple them with the topics that are not covered by the traditional disciplines but nevertheless are important for working professionals in the telecommunications industry. The field of telecommunications is itself very diverse and is comprised of several sub-fields that are related to each other by the fundamental objective of all of them: the movement of information between two different places. Applying this definition to the various industries that are present today, one can easily identify that the field of telecommunications is indeed covering technologies from the very traditional print media to the satellite and computer networks as well as their effects and interactions with the human society.

The large diversity in the industries and technologies that unite to form the field of telecommunications has a direct affect on its academic coverage. Electrical engineering, computer sciences, business management, law, communications, journalism, and public policy are some examples of the diversity of traditional disciplines that have been covered to certain extent within the context of telecom education. This variety of the topics that can be covered within the “telecom” curricula, and the resultant diversity of the competencies or skills that can be attributed to a graduate from the telecom programs,

has created a void in the public understanding of the telecom education in the absence of any reasonable framework to improve such understanding.
The implications of this lack of proper framework for the definition of telecom education are quite widespread and affect all the involved parties. For the students it means that the selection of an institution is unnecessarily complicated by the absence of any taxonomy that can categorize telecom programs based on their strengths in different spheres of telecom education. Moreover, the lack of such taxonomy means that the prevalent system of ranking used to differentiate similar institutions based on their overall value to the students can not be used for telecom education. Academic rankings through peer reviews and statistical methods have been credited with providing the students and parents with "critical quality indicators that can help in making informed decisions" [USNews 2006] as well as improving the market for higher education [Dill 2005]. Similarly this lack of a framework makes it difficult for potential employers to identify the skill sets suitable candidates graduating from the telecom programs possess, thereby decreasing the market potential of the graduates. For the academic institutions themselves, the lack of a framework translates into difficulties in marketing to potential students and their employers, and management of pre-requisite/remedial courses in case a student moves from one telecom program to another.

Based on our analysis of a subset of telecom programs, we argue that it is possible to define the common core of telecom education; paving the way for future standardization and better understanding of this discipline. Our study was undertaken with the assistance of International Telecom Education and Research Association (ITERA), and the data used in the study came from six member institutions. Funding for this effort was provided by the Telecommunications program at the University of Pittsburgh.
This paper is organized as follows: Part 2 of the paper provides a brief overview of the Telecommunications education in the US. Part 3 presents the proposed framework. Data collected as part of the study is outlined in the Part 4. Part 5 presents the methodology and analysis, followed by conclusion in Part 6.

2. Telecommunication Education in the US

Academic programs specializing in telecommunications education are quite widespread both in the United States and in the rest of the world. University of Pittsburgh's telecom program [Pitt 2006] provides a listing of forty such telecom programs at reputed universities across the US. Similar spread of specialized telecom programs can also be seen in the rest of the world.

The diversity of the field of telecommunications is also reflected in the way telecom programs are structured within different universities. While many of the programs are present within schools of engineering, others have been offered by schools of sciences, communications, management, and information sciences. As each school has its own set of concentrations and strengths, we can see a variety of different foci within the field of telecom education originating from different schools and reflected in both the degree objectives and the course content.

Differences also exist in the degrees offered by different programs; with most of the programs specializing at a single level of education, either undergraduate or graduate. Most North American programs offer a Masters degree, while a Bachelors in Telecom is more common in Europe and Asia. [Thompson 2004] Only a few telecommunication programs in the US offer doctorate degree in the field.

3. Proposed Framework

In order to identify a 'common core' within the diverse set of courses and concentrations that are offered by different telecom programs we propose a two level approach. The first level of our approach will analyze the curricula in use at various different telecom programs at a relatively coarse level of granularity, and will provide an estimate of the common core if such exists. In this step, we are concerned about answering some of the fundamental questions that have arisen in the discussion of telecom education, such as the existence (or not existence) of a common core, and the distribution and correlation of curricula that is in use at different programs. As we show in the later sections of this paper, the analysis that we have pursued in this paper is the first level of our proposed framework. Such an analysis is important as it can help us decide if we can create standards and guidelines in naming, organizing, and managing telecom education. So far we believe such an analysis of telecom education has not been done at any level.

Once we are able to answer the basic questions about the feasibility of defining and standardizing telecom education, we can take the analysis to a finer level of granularity. In this part of the proposed framework, we are concerned with the precise definition of the 'common core' and the exact spread of different concentration branches within the telecom programs. The questions that can be answered by this finer analysis will be related to the standardization of telecom curricula and the definition of any naming convention that may go along with the standardization process. Some specific questions that may be answered by this analysis are e.g. what are the standard topics covered in a graduate Wireless Networks course? What remedial courses are needed if a students transfers from program A to B? What set of topics are covered in telecom management degrees?

There are several reasons that justify this two level approach. Firstly, we believe that at the first level, the identification of a basic 'common core' and the distribution of curricula will stimulate an informed discussion on the merits of different strategies and proposals about the future of telecom education standardization efforts. The objectives of the second level of analysis can be then more precisely defined. Secondly, since the finer analysis of curricula will need more participation from telecom programs in sharing the detailed syllabi as well as providing feedback, generating a community wide consensus on the need and importance of such analysis will be beneficial.

The first level of our framework will compare courses from different programs based on the listings of course topics and course descriptions provided by the programs. A linkage will be then defined between two programs if there is more than half overlap in topical coverage of any two compared courses. Therefore the basic element of comparison at this

stage will be a whole course. In doing the comparison on the basis of a whole course we will be masking many lower level details but potentially limiting the accuracy of the analysis in several scenarios:

- A content of a course in program A may be covered in small pieces in several courses at program B. Since the overlap of individual courses will be less than half, a linkage may not be defined.
- The coverage of a topic that is listed in courses at two different programs may not be same.
- The linkage although based on the course descriptions and topical lists will still be subjective.

To refine the result of our first level analysis, the second level of analysis will compare different programs based on the competencies that are covered within the curriculum of the individual programs. Defining a competency as the smallest element of comparison, each topic in a given course will be associated with a unique competency. For example, "Internet addressing" is a competency that can be covered in different courses. Such analysis will enable a more precise definition of the telecom curriculum and will be very helpful in any standardization activity.

4. Data

Data collected as part of this study came from six different member institutions of ITERA. The participants in no particular order are: University of Pittsburgh (PIT), University of Colorado at Boulder (COL), Rochester Institute of Technology (RIT), Ball State University (BSU), Alaska Pacific University (APU), and Western Michigan University (WMU). The listings and descriptions of the graduate courses offered directly through the telecom programs were obtained by correspondence with the respective program directors, along with the detailed list of topics that are covered in the each of the course. The received data was further augmented by the course listing present on the websites of the programs whenever there was missing or incomplete information. Courses that are accepted by a telecom program as electives but are provided by other departments are not considered in this study. Seminars, case studies and labs are also not included. There are a total of 129 courses so obtained. The breakdown by individual programs is given in Table 1.

Institution	**Courses**
PIT	41
COL	29
RIT	12
BSU	21
APU	9
WMU	17

Table 1: Total number of analyzed courses by program

Four of the programs included in our data set offer graduate degrees exclusively, while RIT and WMU which also offers undergraduate degrees. Only courses that are counted towards the graduate degree are considered for the purpose of this study. Three of the six participating schools have courses that are relatively more involved with the technological side of the Telecommunications (RIT, PIT, COL), two (BSU, WMU) offer coursework that is relatively more focused on the human communications side, while one program (APU) advertises a management degree in Telecom. The offered degrees by individual programs are listed in Table 2.

Institution	Offered Degrees
RIT	BS and MS in Telecom Engineering Tech
COL	MS in Telecom
PITT	MS and PhD in Telecom
BSU	MS in Info and Communication Science
APU	MBA in Telecom Management
WMU	BA, MA in Communications

Table 2: Degrees offered by participant programs

5. Methodology and Analysis

As the first step in our analysis we paired all the six participating programs in our study, giving a total of 15 pairs. Each course offered by one program was then compared against each course offered by the other program in a given pair. As all of the courses within the study were one-semester 3-credit graduate level courses, the total lecture time and coursework involved in each of them was generally the same. This ensures that there is no bias in the study towards any specific particular group of courses or programs.

The basis of comparison in our study was the overlap of content between the courses. We used the detailed course breakdowns provided by the participating programs and the course descriptions to estimate if the overlap between a given pair of courses equals or exceeds half the coursework in either course. A binary linkage was then defined between the pair of programs if there is such an overlap in the content of a given pair of courses. We identified a total of 258 such overlaps between the possible pairs of 129 courses included in our study.

We found out that more than half of the courses in our study had linkages with at least half of the participating programs, while 16 courses had linkages with all the programs. The distribution of the linkages accumulated by the courses is given in Figure 1. The closer examination of the distribution reveals that the majority of the linkages (66 out of 113) that occur between 2 and 3 programs happen between PIT and COL, which are two similar programs that offer a large number of courses. This close similarity between PIT and COL and the relatively large number of their courses that are included in the study is largely responsible for the spike seen near the middle of figure 1.

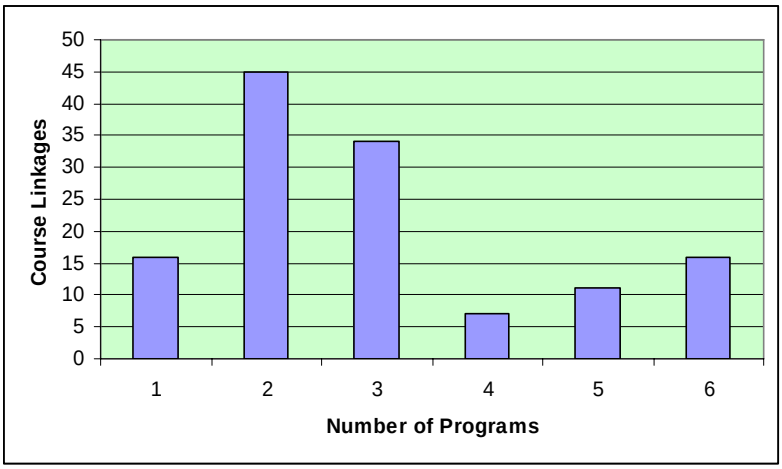

Figure 1: Histogram of the course linkages

The presence of courses that have linkages with all the programs in our study suggests an existence of a 'core' that can be identified as the basic block of telecom education. To gain a better understanding of this core, courses that have linkages with 5 or more programs were then loosely classified into different categories based on their content. Table 3 lists the resultant distribution.

Category	**Number of Courses**
Introduction to Telecom	5
Telecom Management	2
Telecom Policy	3
Computer Networking	8
Wireless/Satellite	5
Telecom Law and Regulation	3
Telecom Systems	1

Table 3: Classification of courses with more than 5 linkages

The correlation between different programs based on the observed number of linkages is shown in Table 4. It is possible for a program to have all the topics covered by another potentially smaller program's courses, thereby giving correlation as high as one. The resulting correlation values are also asymmetric because of the unequal sizes of different programs, as a program with a smaller number of courses may see a large value of correlation with a larger program while the opposite may not be true as the larger program may have other courses that don't have linkages with the courses of the smaller one.

	RIT	COL	PIT	BSU	APU	WMU
RIT	0	0.833	1	0.416	0.5	0.333
COL	0.276	0	0.862	0.206	0.103	0.138
PIT	0.317	0.634	0	0.317	0.219	0.170
BSU	0.285	0.285	0.571	0	0.333	0.524
APU	0.667	0.333	0.889	0.666	0	0.556
WMU	0.411	0.176	0.529	0.705	0.352	0

Table 4: Correlation matrix of linkages between programs

Table 4 suggests the presence of groups within the Telecom programs that have a high degree of correlation between them. (RIT, COL, PITT) and (BSU, WMU) are two such high-correlation groups while (APU) has a relatively high correlation with all of the programs. It is worth pointing out here that this high correlation may an artifact of APU having the least number of courses included in the study. Comparison of the correlation values of Table 4 with the offered degrees listed in Table 2 also suggests that the correlation in the course work of the telecom programs generally follows the naming convention and offered degrees of the programs, as the groups that are offering similar degrees have a high correlation between their programs. Finally, a cluster graph is presented in Figure 2, with each program as a vertex and the length of edges corresponding to the high correlation value between the vertices. The length of the edge between PIT and RIT has been artificially adjusted to make the graph more readable.

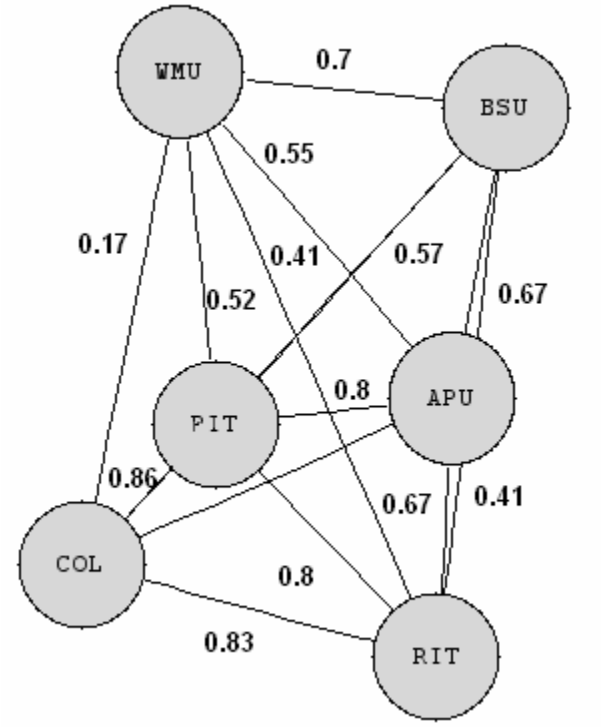

Figure 2: Cluster graph of correlations between Telecom programs

6. Conclusion

In this paper we presented a framework to identify the common core that exists within the Telecommunications education, and using the first level approach of the framework we presented an analysis of six Telecom programs in the US that offered to be included in our study. Based on our analysis, we conclude that there is an identifiable core within the coursework of the programs that we studied, and since all the generally recognized branches of telecom education (technology, management, human communications) were represented within our study set, these results and conclusion can be expected to hold true for the larger community of telecom programs as well.

We also presented a set of course categories that we found were common within our set of programs. This set of course categories can be used as a basis for further analysis and refinement of the telecom core, which we believe is a necessary step in the future organization efforts of telecom programs.

In future work we hope to refine our investigation of the 'telecom core' with a second level of analysis as proposed within our framework which is based on the comparison of competencies in different programs.

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