

# Core Competencies for Telecom Programs Curricula

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## 1. Introduction

The variety of topics that can be covered within a “Telecommunications” curriculum, and the resultant diversity of the competencies or skills that can be attributed to a graduate from a telecommunication program, creates problems for students, employers and institutions in evaluating and choosing the skill sets desirable for their future decisions. For students, it complicates the selection of an institution/program to study in, for employers, it affects their capability to identify the skill sets that graduates of a telecom program possess and to academic institutions, it affects the way they can market and structure their programs. An adequate taxonomy that categorizes the skills and competencies of the different areas that compose telecom education would alleviate many of these problems.

This work presents an extension of the analysis of the curricula of several graduate telecommunication programs presented in (Iqbal and Thompson 2006). This analysis compares different programs based on the competencies that are covered within their curriculum.

The results of our analysis show the sets of competencies that are associated with the areas of telecom education and how prevalent they are among the set of institutions that were contemplated in the study. We hope these results can serve as the basis for future curriculum definition projects in academic institutions as well as to promote a set of criteria for the certification of telecom programs.

## 2. Previous work and definitions

A framework for analyzing telecom education was defined in (Iqbal and Thompson 2006) and was composed of a first level analysis based on course description information of several telecom programs and a second level analysis based on the competencies covered within the curriculum of each of the programs.

The results of the first level analysis were presented at the ITERA 2006 conference and among other things; it concluded that there was a core set of courses within the coursework of the telecommunication programs analyzed (6 programs) which then

justified proceeding with the second level analysis that was mentioned in the proposed framework.

This paper presents the second level analysis for the telecommunication program at 8 universities. This analysis is based on the determination of the competencies that are covered by the courses in each academic program with the objective of finding out the core set of competencies for telecom education within the sample set of universities. In order to obtain the required competency information for each course, a detailed syllabus of the course was required. Many of the course syllabi that were used in this work were obtained through collaboration with the Telecommunications program directors and/or related faculty of the ITERA institutions participating in this study.

For the purposes of this study, a competency X is assigned to a course if the course provides a student with the capability to understand and apply the concepts of X. For example, in the case where X is *Data Multiplexing* this competency will be associated to courses that treat topics where a student will acquire knowledge that allows him/her to understand and apply *Data Multiplexing* concepts. Most of the competencies can be obtained by a student by careful analysis of the content reviewed in a week's worth of class or a book's chapter worth of content.

Table 1 lists the universities and the number of courses per university that were considered in the study. The courses used in this study were those for which adequate syllabus information was available/provided at the time of the study. Only the graduate Telecommunications program for each University was considered with the exception of WMU. Additionally, some programs might be under represented in this analysis because of the lack of enough syllabi information to determine the competencies taught in the program. This is the case for WMU and APU. In total, 50 courses were analyzed.

No.	University	# of courses
1	Ball State University (BSU)	5
2	Rochester Institute of Technology (RIT)	10
3	Alaska Pacific University (APU)	2
4	Western Michigan University (WMU)	3
5	University of Colorado at Boulder (COLO)	7
6	University of Pittsburgh (PITT)	13
7	Murray State University (MSU)	5
8	NorthEastern University (NEU)	5

**Table 1. Number of courses per program included in the study**

### 3. Analysis and Results

A total of 117 competencies were identified over the 50 courses analyzed. These competencies were further grouped into 10 knowledge areas as shown in Table 2. As indicated in the table the greatest number of identified competencies are related to basic telecommunications systems theory which was to be expected. The area of Advanced Telecom Systems Theory covered a diverse set of competencies offered by many different courses throughout the programs analyzed which justifies its high competency count.

No.	Knowledge Area	# of Competencies
1	Networking Basics	12
2	Networking Technology and Protocols	12
3	Wireless Communication Basics	10
4	Wireless Technology and Protocols	8
5	Advanced Networking Concepts	12
6	Basic Telecom Systems Theory	18
7	Advanced Telecom Systems Theory	17
8	Telecommunication Management	12
9	Telecom Regulation	6
10	Advanced Wireless Systems Theory	10

**Table 2. Competencies per Knowledge Area**

The number of courses that covered a particular knowledge area is shown in Table 3. A course may cover topics over more than one knowledge area and in the table it has been counted once for each area. Most of the courses covered topics related to telecom systems and networking concepts.

No.	Knowledge Area	# of Courses
1	Networking Basics	18
2	Networking Technology and Protocols	19
3	Wireless Communication Basics	13
4	Wireless Technology and Protocols	5
5	Advanced Networking Concepts	18
6	Basic Telecom Systems Theory	18
7	Advanced Telecom Systems Theory	20
8	Telecommunication Management	10
9	Telecom Regulation	11
10	Advanced Wireless Systems Theory	7

**Table 3. Number of Courses per Knowledge Area**

### 3.1 Analysis of the distribution of competencies

A breakdown of how many competencies each program covers on each knowledge area is shown in Table 4. The information in this table can be used to compare how similar are the programs considered in the study. However, given the different degree of depth that some competencies receive in certain schools, Table 5 shows the degree of concentration a given knowledge area is given in each program.

Table 5 provides a better look into the similarities or differences among programs and helps in the classification of each of them into one of the several categories or “species” of programs currently present in U.S. Telecom education (Technical oriented, Management oriented, Human communication/Media production oriented). Further extension of this work could lead to the elaboration of criteria that determines the amount of coverage that each knowledge area should have based on the particular category to which a program wishes to belong.

Knowledge Area	BSU	RIT	APU	WMU	COLO	PITT	MSU	NEU
Networking Basics	7	5	3	1	8	14	7	3
Networking Technology and Protocols	9	4	1	0	5	11	0	8
Wireless Communication Basics	3	3	1	1	5	10	1	2
Wireless Technology and Protocols	2	0	0	0	3	13	0	0
Advanced Networking Concepts	4	3	0	0	4	13	1	2
Basic Telecomm Systems Theory	11	11	1	3	0	13	6	8
Advanced Telecomm Systems Theory	3	8	0	0	5	9	2	3
Telecommunication Management	6	3	0	1	3	1	4	5
Telecomm Regulation	5	5	6	2	6	4	0	1
Advanced Wireless Systems Theory	0	2	0	0	1	11	0	1
<b>Total #</b>	<b>50</b>	<b>44</b>	<b>12</b>	<b>8</b>	<b>40</b>	<b>99</b>	<b>21</b>	<b>33</b>

**Table 4. Competencies per Program**

Knowledge Area	BSU	RIT	APU	WMU	COLO	PITT	MSU	NEU
Networking Basics	14%	11%	25%	13%	20%	14%	33%	9%
Networking Technology and Protocols	18%	9%	8%	0%	13%	11%	0%	24%
Wireless Communication Basics	6%	7%	8%	13%	13%	10%	5%	6%
Wireless Technology and Protocols	4%	0%	0%	0%	8%	13%	0%	0%
Advanced Networking Concepts	8%	7%	0%	0%	10%	13%	5%	6%
Basic Telecomm Systems Theory	22%	25%	8%	38%	0%	13%	29%	24%
Advanced Telecomm Systems Theory	6%	18%	0%	0%	13%	9%	10%	9%
Telecommunication Management	12%	7%	0%	13%	8%	1%	19%	15%
Telecomm Regulation	10%	11%	50%	25%	15%	4%	0%	3%
Advanced Wireless Systems Theory	0%	5%	0%	0%	3%	11%	0%	3%

**Table 5. Concentration of competencies per program**

### 3.2. Determination of the core competencies for telecom education

Of the 117 competencies determined from the available data, those that were present in three or more of the Telecommunication programs analyzed were selected as core competencies. We decided to determine the core competencies based on the number of programs in which a competency is present instead of the number of courses in which it

was present in order to avoid introducing a bias into the set because of competencies that are present in more than one course in the same program. This analysis generated 40 competencies which are listed in table 6.

Competency	Knowledge Area	# of Progs
Computer Network Fundamentals	Networking Basics	7
Internetworking Basics	Networking Basics	7
LAN Technologies and Concepts	Networking Basics	6
OSI Protocol Stack	Networking Basics	4
WAN Technologies and Concepts	Networking Basics	4
Internet Structure and Protocol Overview	Networking Basics	3
SONET/SDH	Networking Technology and Protocols	4
LAN Protocols	Networking Technology and Protocols	4
Wireless LAN Systems	Networking Technology and Protocols	4
Asynchronous Transfer Mode	Networking Technology and Protocols	3
Transport Protocols	Networking Technology and Protocols	3
Voice over IP	Networking Technology and Protocols	3
Wireless Transmission Systems	Wireless Communication Basics	5
Antenna operation fundamentals	Wireless Communication Basics	3
Cellular Networks Fundamentals	Wireless Communication Basics	3
CDMA Fundamentals	Wireless Communication Basics	3
Satellite Communication Basics	Wireless Communication Basics	3
Network Security Basics	Advanced Networking Concepts	3
Security Assessment Methods	Advanced Networking Concepts	3
QoS analysis	Advanced Networking Concepts	3
Traffic Management	Advanced Networking Concepts	3
Telephone networks	Basic Telecom Systems Theory	6
Signal Multiplexing	Basic Telecom Systems Theory	4
Signals and Systems Concepts	Basic Telecom Systems Theory	5
Digital Transmission Fundamentals	Basic Telecom Systems Theory	4
Signal propagation	Basic Telecom Systems Theory	3
Basic Digital Modulation Techniques	Basic Telecom Systems Theory	3
Network Design Basics	Advanced Telecom Systems Theory	3
Traffic engineering principles	Advanced Telecom Systems Theory	3
Access Network Design	Advanced Telecom Systems Theory	3
Digital encoding	Advanced Telecom Systems Theory	3
Budget Preparation	Telecommunication Management	4
Project Planning and Management	Telecommunication Management	3
Microeconomic Principles	Telecommunication Management	3
Spectrum Regulation Basics	Telecom Regulation	5
Telephone Regulation	Telecom Regulation	5
Global Regulatory Issues	Telecom Regulation	5
Cable Television Regulation	Telecom Regulation	4
Telecom Regulation Basics	Telecom Regulation	4
Advanced Regulatory Issues	Telecom Regulation	3

**Table 6. Core competencies**

Its worth mentioning that our competency analysis was done over the 8 programs that we considered which include programs with different areas of concentration (technical vs. management oriented). A competency analysis by type of telecommunications program would give a different result applicable to that particular type. However, we consider that our analysis so far reveals a set of core competencies that should be considered by all telecommunication programs. Refinements to this core set can be made as more syllabi information becomes available for this study.

#### **4. Conclusions and future work**

We have identified a core set of competencies for telecommunication education. This set can be used to define the core curriculum requirements for education in this sector and provide the basis for telecommunication program certification criteria in the future.

Further work should include expanding the number of courses and programs covered in the analysis in order to obtain refined competency sets for each of the types telecom programs present in academia.

#### **Acknowledgements**

The authors would like to thank the program directors and faculty from the telecom programs of the 8 universities that helped us with the study.

#### **References**

Iqbal, Hammad and Richard Thompson (2006), “*A Framework for Defining Graduate Telecommunications Education*”, ITERA 2006 Conference , Las Vegas, NV.

Thompson, R. (June 2004) *Telecommunications - A Discipline of Our Own*. ITERA Education Research Papers. Retrieved on 27 August/ 2006 from [http://www.itera.org/papers/04\\_Thompson\\_Professor\\_03\\_b.doc](http://www.itera.org/papers/04_Thompson_Professor_03_b.doc)

ABET (2006), “*Criteria for accrediting engineering programs*”, available at: <http://www.abet.org/Linked%20Documents-UPDATE/Criteria%20and%20PP/E001%2007-08%20EAC%20Criteria%2011-15-06.pdf>