within the same competency areas that include competencies specified for MSIS graduates, but to be gained at an earlier stage. Specifically, the prerequisite competencies are included in the *Data, Information, & Content Management*, *IT Infrastructure*, and *Systems Development and Deployment* areas (Figure 2; see also Section 5 for details).

As for the Individual Foundational Competencies, MSIS 2016 does not make specific assumptions regarding the competencies that incoming students have. It does, however, assume that the undergraduate/first cycle degree requirement has given students competencies in oral communication, written communication, leadership and collaboration, negotiation, analytical and critical thinking, creativity, ethical analysis, and problem solving (as specified, for example, in IS 2010). As a master's degree, MSIS 2016 will be building on these competencies, strengthening them and bringing them to a level that is compatible with master's level expectations.

Please note that MSIS 2016 will not take a stand regarding the way in which the prerequisite competencies can be acquired. Clearly one way to get them is to <u>have an undergraduate degree in Information Systems or in a related applied computing discipline</u>. It is also possible that an incoming student has acquired the required competencies through <u>work experience</u> (which, of course, needs to be verified with appropriate testing). Finally, the prerequisite competencies can be achieved by taking <u>bridge courses</u> before the actual graduate program starts. Whichever mechanism is used, it is essential that the competencies are attained in a way that allows the student to fully use the prerequisite competencies as part of the master's level study process—the master's program should be built on the assumption that all students have the prerequisite competencies and are able to use them.

4.6 Core Competencies vs. Specialized Competencies

As indicated in Figure 2, Specialized competencies consist of additional Computing and IS Management competencies that build on the core competencies and allow the graduates to perform more sophisticated tasks and act in more specialized professional roles. It is typical for MSIS programs to include <u>career tracks</u> that require the development of specialized competencies within a specific area of expert knowledge, such as security or analytics.
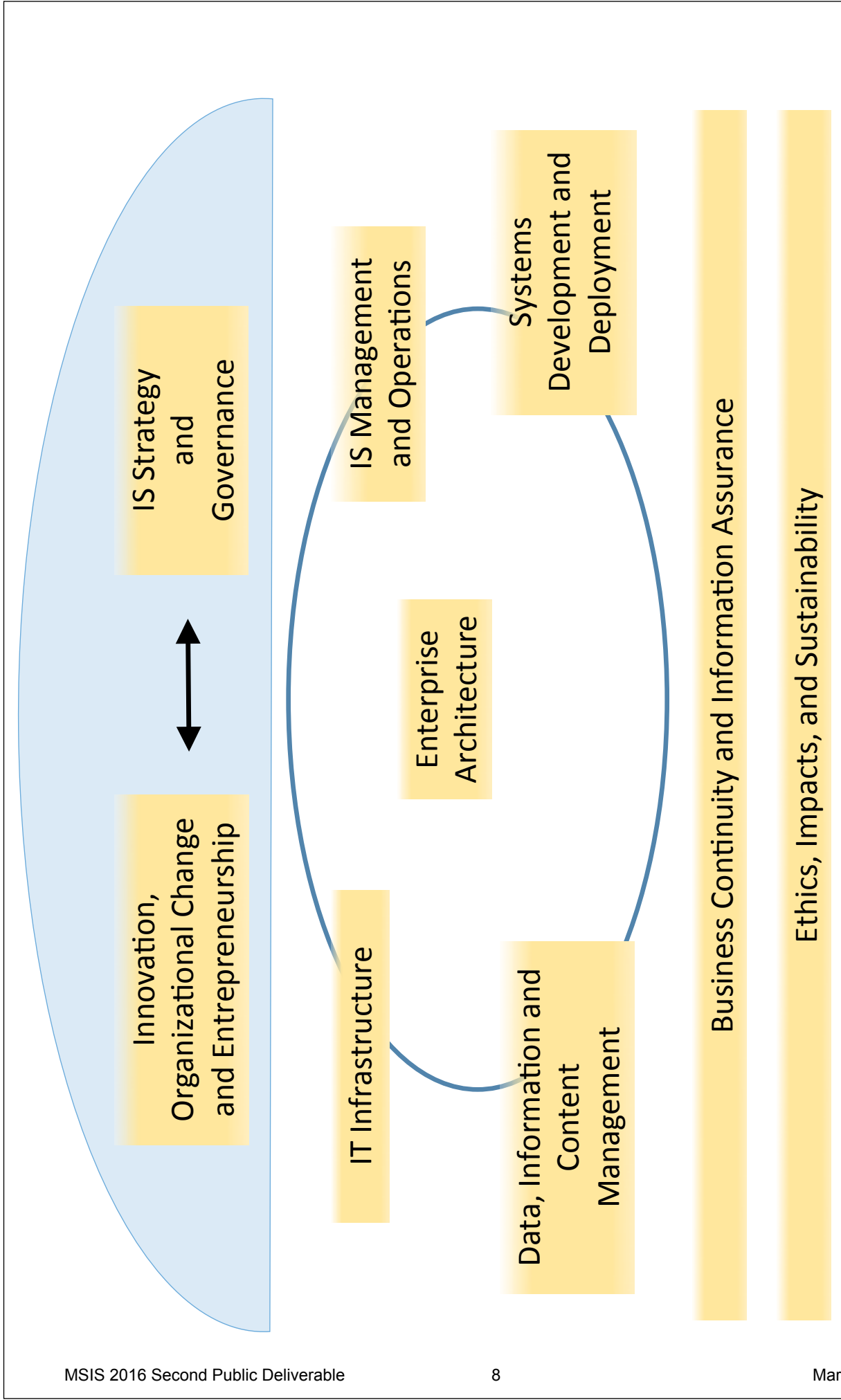
5. Competency Specifications

This section will provide detailed descriptions of the nine competency areas for Computing and IS Management (overview in Figure 3; details in Section 5.1) and the Individual Foundational Competencies (Section 5.2).

5.1 Specifications of Competency Areas, Competency Categories, and Competencies for Computing and IS Management

The task force has benefited significantly from the following sources when developing the competency structure proposed in this section:

Figure 3. MSIS 2016 Computing and IS Management Competency Areas

MSIS 2016 Competency Areas: Computing and IS Management

- IS Strategy and Governance
- Innovation, Organizational Change and Entrepreneurship
- IS Management and Operations
- Systems Development and Deployment
- Enterprise Architecture
- IT Infrastructure
- Data, Information and Content Management
- Business Continuity and Information Assurance
- Ethics, Impacts, and Sustainability

- *The European e-Competence Framework (e-CF) 3.0: a Common European Framework for ICT Professionals in All Industry Sectors* (www.ecompetences.eu)
- *The Skills Framework for the Information Age (SFIA)* (www.sfia-online.org/en)
- *O*NET (Occupational Information Network)* (www.onetonline.org)
- *2012 Clinger-Cohen Core Competencies & Learning Objectives* (https://cio.gov/wp-content/uploads/downloads/2013/02/2012-Learning-Objectives-Final.pdf)

The task force gratefully acknowledges the significant impact of all these outstanding specifications of IT professional competencies on the process of MSIS 2016 competency development. In addition to these specifications, the task force utilized primary data collected from MSIS program directors, current students, alumni, and corporate stakeholders regarding graduate competency priorities.

Material from all these sources was integrated in a multi-staged grouping process that took place at the competency category level: the categories were first grouped into competency areas and then individual competencies were articulated for each of the competency categories. A discussed above, the individual competencies are less stable than the areas and categories, and they are not intended to be exhaustive.

Before the detailed descriptions, the document includes two tables: first, Table 1 presents a summary of the competency areas and categories to provide a convenient overview of the Computing and IS Management competencies. Second, Table 2 presents a mapping of IS 2010 high-level competencies and core MSIS 2016 structures.

Table 1. MSIS 2016 Proposed Competency Areas and Competency Categories

MSIS 2016 Proposed Competency Areas and Competency Categories
MSIS 2016 Computing and IS Management Competency Areas

Business Continuity and Information Assurance		
	1	Managing and implementing cybersecurity
	2	Responding to and managing IS problems
	3	Monitoring system operations
	4	Managing system recovery
	5	Managing Information Systems risks
	6	Protecting IT assets
	7	Developing information assurance strategy
	8	Continuity engineering
	9	Implementing and managing quality audit processes
	10	Assuring safety throughout systems lifecycle
Data, Information and Content Management		
		Pre-master's
	1	Understanding key data and information concepts and the data and information management lifecycle
	2	Capturing and structuring data and information requirements using appropriate conceptual modeling techniques
	3	Developing a logical level representation of data based on a conceptual model
	4	Implementing a database solution to serve systems consisting of multiple applications
	5	Using a contemporary data manipulation and retrieval language effectively
		Master's
	6	Selecting appropriate data management technologies based on the needs of the domain
	7	Securing domain data and protecting user privacy and organizational intellectual property using appropriate technical solutions
	8	Designing and implementing a data warehouse using a contemporary architectural solution
	9	Creating a scalable infrastructure for large amounts of data using parallel and distributed technologies
	10	Developing and implementing organizational information management policies and processes
	11	Integrating and preparing data captured from various sources for analytical use
	12	Selecting and using appropriate analytics methods

	13	Designing and implementing architectures for organizational content management systems	

Enterprise Architecture

	1	Understanding enterprise architecture principles and the value it provides to businesses
	2	Participating in building and maintaining an EA
	3	Communicating and deploying an EA
	4	Using an EA to influence IS/IT related organizational improvement projects

Ethics, Impacts and Sustainability

	1	Designing and managing sustainable IT operations
	2	Managing IT facilities sustainably
	3	Aligning IT with organizational sustainability policy
	4	Managing sustainable procurement practice
	5	Managing contracts ethically
	6	Maintaining compliance with legislation, regulations, and standards
	7	Ensuring that protection of privacy and integrity guide all IT practices
	8	Maintaining an ethical culture
	9	Understanding the ethical implications of IS-related decisions

Innovation, Organizational Change and Entrepreneurship

	1	Understanding where and how to monitor the technology environment
	2	Engaging in entrepreneurial thinking
	3	Developing a business plan
	4	Innovating by exploiting an emerging method or technology
	5	Understanding the diffusion curve and how to leverage different adopters
	6	Understanding how to apply creative problem solving to technology-related issues
	7	Contributing to organizational development
	8	Identifying opportunities for and designing process improvement
	9	Analyzing and documenting business activities

IS Management and Operations

	Pre-master's	
	1	Know and apply widely used Project Management tools and techniques
	Master's	

	2	Managing the IS/IT function
	3	Managing IS/IT staff
	4	Managing IS/IT service production
	5	Managing IS/IT sourcing models
	6	Managing and coordinating information resources
	7	Implementing relevant IT governance frameworks withing the organization based on strategic guidance
	8	Understanding laws and regulations directly affeting IS/IT management and operations
	9	Managing IS/IT projects and programs
	10	Managing IS/IT project portfolios
	11	Managing software and hardware development and maintenance
IS Strategy and Governance		
	1	Conducting IS strategic analysis
	2	Making a financial case for IS
	3	Managing IS/IT sourcing strategies
	4	Engaging in IS strategic planning
	5	Planning and implementing IS governance
	6	Understanding laws and regulations directly affecting IT management and operations
	7	Planning for and improving sustainability
IT Infrastructure		
	Pre-master's	
	1	Designing data communication networks and data center and server solutions
	2	Selecting appropriate client devices to support the needs of a domain
	3	Securing IT infrastructures
	Master's	
	4	Specifying and monitoring infrastructure contracts
	5	Negotiating contracts and managing infrastructure vendors
	6	Managing infrastructure risks
	7	Designing virtualization solutions
	8	Designing infrastructure solutions using external service provider(s) (cloud computing)
	9	Maintaining a set of standards and policies and understand the key laws and regulations to relevant infrastructure decisions
	10	Monitoring emerging technologies to understand their potential to support the domain

		Role of Information Systems in Organizations (Foundational Understanding of IS)
	Pre-master's	
		To be specified later
Systems Development and Deployment		
	Pre-master's	
	1	Documenting existing systems
	2	Specifying and documenting systems requirements
	3	Identifying and selecting from systems design and implementation alternatives
	4	Designing systems
	5	Designing user experiences
	6	Implementing a systems solution using a modern program language
	Master's	
	7	Selecting between systems development approaches
	8	Managing plan-based, hybrid, and agile development approaches
	9	Specifying and documenting systems requirements
	10	Designing systems
	11	Implementing and testing an application
	12	Installing and integrating a new application
	13	Managing external systems development resources
	14	Managing IS development projects

Table 2a. Comparison between high-level structures of IS 2010 (High-Level IS Capabilities) and MSIS 2016 (Competency Areas)

Comparison between MSIS 2016 Competency Areas and IS 2010 High-level IS Capabilities

IS 2010 High-Level IS Capabilities	MSIS 2016 Competency Areas
Improving organizational processes	Innovation, Organizational Change, and Entrepreneurship
Exploiting opportunities created by technology innovations	IS Strategy and Governance Innovation, Organizational Change, and Entrepreneurship
Understanding and addressing information requirements	Data, Information & Content Management
Designing and managing enterprise architecture	Enterprise Architecture
Identifying and evaluating solution and sourcing alternatives	Systems Development and Deployment
Securing data and infrastructure	Business Continuity and Information Assurance
Understanding, managing, and controlling IT risks	Business Continuity and Information Assurance
	IS Management and Operations
	IT Infrastructure
	Ethics and Impacts

Table 2b. Comparison between high-level structures of IS 2010 (Knowledge and Skills) and MSIS 2016 (Competency Areas)

Comparison with IS 2010 Knowledge and Skills of IS Graduates

IS 2010 Knowledge and Skills	MSIS 2016 Competency Areas
Identifying and designing opportunities for IT-enabled organizational improvement	Innovation, Organizational Change, and Entrepreneurship IS Strategy and Governance Data, Information, and Content Management
Analyzing trade-offs	Enterprise Architecture Systems Development and Deployment
Designing and implementing information systems solutions	Systems Development and Deployment Enterprise architecture IT Infrastructure Data, Information, and Content Management
Managing ongoing information technology operations	IS Management and Operations Business Continuity and Information Assurance