UNIVERSITY OF TEXAS ARLINGTON

Systems Engineering (IE-5351)

Final Project

Group 5

Nikolai Drigalenko (nikolai.drigalenko@mavs.uta.edu)
Devansh Kochar
Danish Inamdar
Omideh Taghavi
Krunal Bhagat

Assignment Task

- Review information related to the Systems Engineering Body of Knowledge (SEBoK) and perform the following:
  - Provide an introduction to the SEBoK including history, purpose, description, current status, relationship to other systems engineering reference sources (e.g., INCOSE handbook, systems engineering standards).
  - Provide an overview of the SEBoK including each of the major parts.

Assignment Task

- Topic Analysis: Develop a presentation for the following topic: security engineering/cyber security.
  - At least 4 references must be cited for the topic not including the INCOSE handbook, SEBoK, Wikipedia, a consultant page, etc. Use journal papers, conference papers, books, and technical reports (INCOSE, IEEE, etc.) for your references. Note that journal papers, conference papers, and many books are now available electronically.
  - Provide a detailed overview of the topic including history, purpose, description, associated method(s), current status, as applicable.
  - Identify how this topic relates to systems engineering and what SE processes it relate to (if any)?
  - Identify how Millennium Systems or another organization can use the topic (or an understanding of the topic) to its benefit.

SEBoK – Introduction

- “The Guide to the Systems Engineering Body of Knowledge (SEBoK) is a living authoritative guide that discusses knowledge relevant to Systems Engineering. SEBoK does not contain all of this knowledge itself, but provides a starting point and key resources to allow the reader to navigate the wider body of knowledge that exists in published sources. To do this SEBoK:
  - Defines relevant knowledge and structures it to facilitate understanding.
  - Provides short discussions of key idea, principles and concepts within that structure.
  - Points to reference sources important to the discipline, which explore these ideas in more detail.”

(SEBoK, 2019)

SEBoK – History

- Created by the Body of Knowledge and Curriculum to Advance Systems Engineering (BKCASE)
  - Developed from 2009 to 2012
  - Organized by the Stevens Institute of Technology and the Naval Postgraduate School in coordination with several professional societies
  - Sponsored by the U.S. Department of Defense (DoD)
  - 75+ contributors worldwide
- v.0.25 prototype released 2010
- v.0.5 released 2011 switched to wiki-based (http://www.sebokwiki.org)
- SEBoK content is managed by an editorial board
  - Starting in 2013, anyone in the community can suggest changes, but the board reviews all recommendation before they are implemented
- 21 releases of the SEBoK to date, collected into 13 main releases

(SEBoK, 2019)

SEBoK – Purpose

- Describes the boundaries, terminology, content, and structure of SE
- "Supports 6 broad purposes:
  - ***Inform practice:*** Inform systems engineers about the boundaries, terminology, and structure of their discipline and point them to useful information needed to practice SE in any application domain.
  - ***Inform research:*** Inform researchers about the limitations and gaps in current SE knowledge that should help guide their research agenda.
  - ***Inform interactors:*** Inform performers in interacting disciplines (system implementation, project and enterprise management, other disciplines) and other stakeholders of the nature and value of SE.
  - ***Inform curriculum developers:*** Inform organizations defining the content that should be common in undergraduate and graduate programs in SE.
  - ***Inform certifiers:*** Inform organizations certifying individuals as qualified to practice systems engineering.
  - ***Inform SE staffing:*** Inform organizations and managers deciding which competencies that practicing systems engineers should possess in various roles ranging from apprentice to expert."

(SEBoK, 2019)

SEBoK – Description

- Systems Engineering Body of Knowledge (SEBoK)
- Wiki based collection of references for systems engineering
- Electronic articles about systems engineering topics built on MediaWiki technology (same technology used by Wikipedia)
  - Built using MediaWiki v.1.24.1
- Consists of 7 parts broken into 26 knowledge areas and over 100 articles
  - Includes 6 use cases, 9 case studies, and 6 vignettes

(SEBoK, 2019)

SEBoK – Current Status

- Current version v.2.1 released October 2019, includes the following changes:
  - Added bylines to articles
  - Glossary bubbles are gray background with black text
  - New articles and updated content (plus videos)
- BKCASE currently overseen by governing board of 3 associations:
  - International Council on Systems Engineering (INCOSE)
  - Systems Engineering Research Center (SERC)
  - Institute of Electrical and Electronics Engineers Computer Society (IEEE-CS)
- Starting in January 2020, IEEE-CS will be replaced with the Institute of Electrical Engineering Systems Council (IEEE-SC)

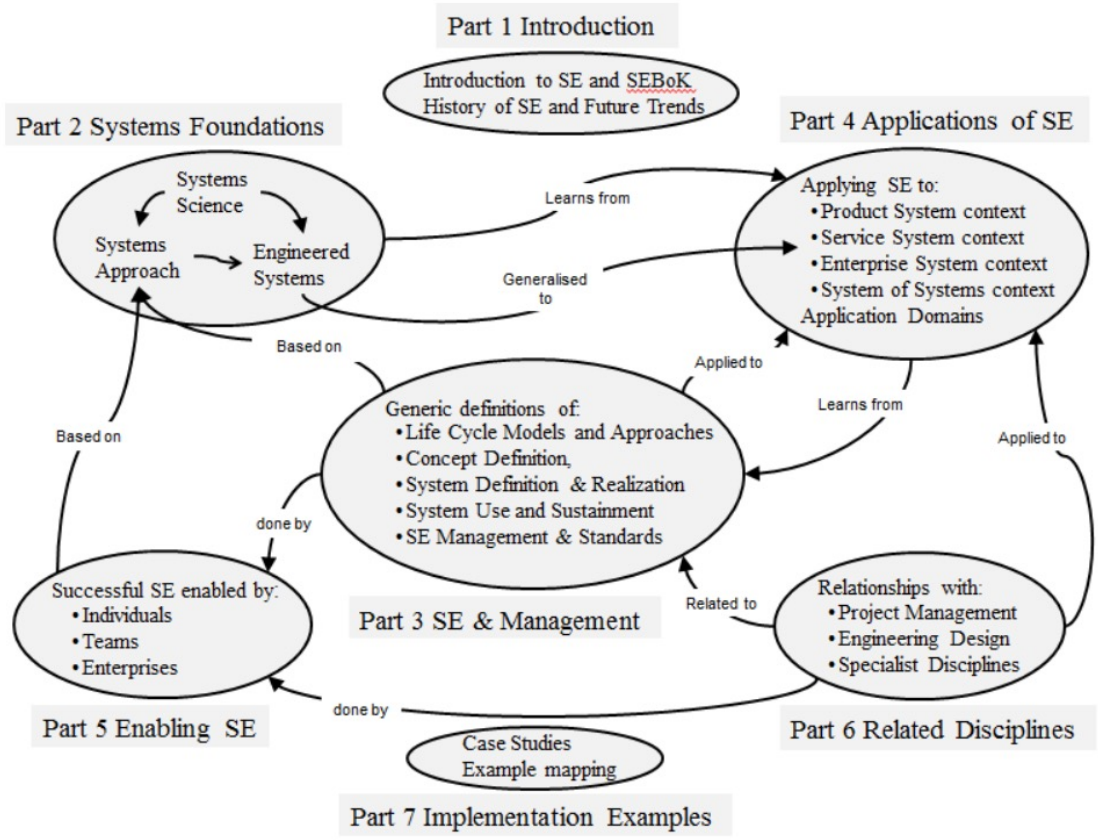
(SEBoK, 2019)

SEBoK – Relationship to other SE reference sources

- Each article includes **Works Cited**, **Primary References**, and **Additional References**
- **Works Cited** are the full citations for articles, books, and websites found in the article
- **Primary References** are links to other bodies of knowledge
  - Reference provides more detailed information for particular topic
  - Each reference has its own webpage containing complete bibliographic information, list of all the articles that cite it, and description explaining how it addresses a specific knowledge area
  - A few examples include:
    - Decision Making for Systems Engineering and Management
    - Handbook of Systems Engineering and Management
    - INCOSE Systems Engineering Handbook
- **Additional References** are more in depth than the primary references

(SEBoK, 2019)

SEBoK – Overview



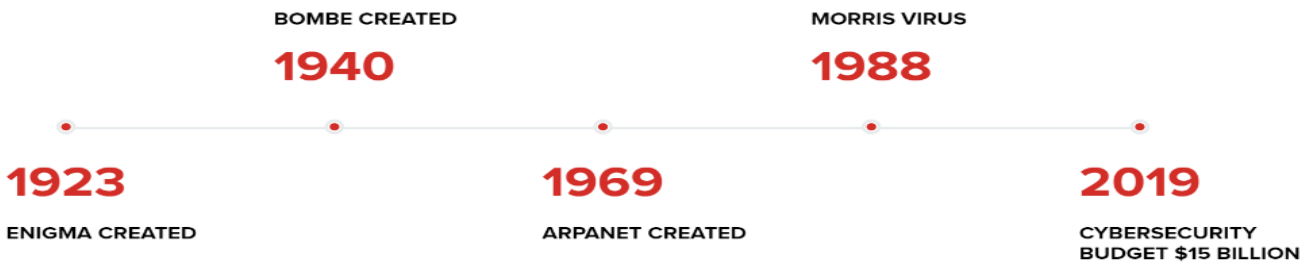
(SEBoK, 2019)

CyberSecurity

- “Cybersecurity” is a combination of the words “Cyberspace” and “security” (Singer & Friedman, 2014)
  - Cyberspace is defined as “The realm of computer networks (and the users behind them) in which information is stored, shared, and communicated online. “
  - Security is defined as “When the difference between the expected behavior differs from the actual behavior from an adversary.”
  - Combined, the definition becomes “When the difference between the expected behavior of a computer network deviates from the actual behavior due to the activities of an adversarial user”.”

History of Cybersecurity

- Enigma and Bombe is one of the first recorded instance of one machine decoding another's cryptic messages (Davies, 1999)
  - Was a major factor in Allies winning World War 2
- First Viruses
  - First virus spread by web was "Morris Worm." Created by a graduate student. (Orman, 2003)
    - Originally meant to determine the size of the internet, a typo in his code caused most of the internet to be infected.
- In 2019, the US Government has allocated $15 billion for cybersecurity. (White House, 2019) .



Purpose of Cybersecurity

- Cybersecurity is meant to protect computers, computer hardware, software, networks and data from unauthorized access, vulnerabilities supplied through Internet by cyber criminals, terrorist groups and hackers. (Goutam, 2015).

Current Trends

- The socio-technical trends that are discussed below and are most likely to have an impact on the cyber-security environment over the next decade. (Dupont, 2013).
  - Cloud Computing-The unparalleled flexibility of cloud computing that promises reduced costs to companies that use it make it an irresistible proposition, particularly in these turbulent financial times.
  - Big Data-The term big data reflects the appearance in recent years of datasets containing gigantic volumes of un-structured or disparate information that may be analyzed computationally to find trends and patterns.
  - The Internet of Things- This term refers to the growing interaction between the physical and digital worlds through sensors and data capture devices integrated into the objects around us.

Notable Application: Security Hacking

- Security Hacking: Process of Exploring, Experimenting, and penetrating computer networks.(Jagnarine, 2005).
- White Hat Hackers
  - "Keep the bad guys out of securing sensitive information." (citation)
    - Penetrate the security networks of organizations to help them secure their information. White Hats are typically employed by said organization or a consulting firm.
- Black Hat Hackers (aka crackers)
  - Do the same as white hat hackers, but use sensitive information for illegal purposes instead (such as securities fraud.)

References

- SEBoK Introduction. (2 June 2019). SEBoK, . Retrieved 02:33, November 21, 2019 from https://sebokwiki.org/w/index.php?title=SEBoK_Introduction&oldid=57078.
- Foundations of Systems Engineering. (2 June 2019). SEBoK, . Retrieved 02:37, November 21, 2019 from https://sebokwiki.org/w/index.php?title=Foundations_of_Systems_Engineering&oldid=57089.
- Systems Engineering and Management. (2 June 2019). SEBoK, . Retrieved 02:37, November 21, 2019 from https://sebokwiki.org/w/index.php?title=Systems_Engineering_and_Management&oldid=57467.
- Applications of Systems Engineering. (2 June 2019). SEBoK, . Retrieved 02:37, November 21, 2019 from https://sebokwiki.org/w/index.php?title=Applications_of_Systems_Engineering&oldid=57176.
- Enabling Systems Engineering. (2 June 2019). SEBoK, . Retrieved 02:37, November 21, 2019 from https://sebokwiki.org/w/index.php?title=Enabling_Systems_Engineering&oldid=57205.
- Related Disciplines. (2 June 2019). SEBoK, . Retrieved 02:37, November 21, 2019 from https://sebokwiki.org/w/index.php?title=Related_Disciplines&oldid=57222.
- Systems Engineering Implementation Examples. (2 June 2019). SEBoK, . Retrieved 02:37, November 21, 2019 from https://sebokwiki.org/w/index.php?title=Systems_Engineering_Implementation_Examples&oldid=57341.

References

- Jagnarine, A. A. (2005). The Role of White Hat Hackers in Information Security. *Communications*. http://digitalcommons.pace.edu/cgi/viewcontent.cgi?article=1012&context=honorscollege_theses
- Orman, H. (2003). *The Morris Worm HILARIE ORMAN Purple Streak*. 35–43 https://ieeexplore-ieee-org.ezproxy.napier.ac.uk/ielx5/8013/27717/01236233.pdf?tp=&arnumber=1236233&isnumber=27717
- Davies, D. W. (1999). The bombe a remarkable logic machine. *Cryptologia*, *23*(2), 108–138. https://doi.org/10.1080/0161-119991887793
- White House Report (2019). *Cyber Security Funding* https://www.whitehouse.gov/wp-content/uploads/2019/03/ap_24_cyber_security-fy2020.pdf
- Singer, P. W., & Friedman, A. (2014). *Cybersecurity and cyberwar: what everyone needs to know*. New York: Oxford University Press.

References

- Dupont, B. (2013). Cybersecurity Futures: How Can We Regulate Emergent Risks? *Technology Innovation Management Review*, *3*(7), 6–11. https://doi.org/10.22215/timreview700

- KumarGoutam, R. (2015). Importance of Cyber Security. *International Journal of Computer Applications*, *111*(7), 14–17. https://doi.org/10.5120/19550-1250

Backup Slides

Part 1 – SEBoK Introduction

- Introduction to the main concepts of the SEBoK as well as the organization and uses of the SEBoK itself.
- Covers the scope, structure, uses, and evolution of the SEBoK.
- Explains the scope, context, and structure of the SEBoK, and of systems engineering.
- Contains the following Knowledge Areas:
  - Introduction to the SEBoK
  - Introduction to Systems Engineering
  - Introduction to SE Transformation
  - Digital Engineering
  - Set-Based Design
  - SEBoK Users and Uses

(SEBoK, 2019)

Part 2 – Foundations of Systems Engineering

- Overview of the concepts of systems science and their relevance to systems engineering.
- Describes the characteristics of systems and foundation principles of SE.
- Provides an introduction and overview of areas of knowledge which provide the foundations of SE.
- Contains the following Knowledge Areas:
  - Systems Fundamentals
  - Systems Approach Applied to Engineered Systems
  - Systems Science
  - Systems Thinking
  - Representing Systems with Models

(SEBoK, 2019)

Part 3 – Systems Engineering and Management

- Traditional systems engineering knowledge, including life cycle concepts, the processes that support systems engineering activities, systems engineering management considerations, and key standards.
- Addresses how SE is conducted and covers life cycle models and processes, SE development and evolution practices, management processes
- Describes generic knowledge on the practice of SE and related management activities.
- Contains the following Knowledge Areas:

- Introduction to Life Cycle Processes
- Life Cycle Models
- Concept Definition
- System Definition
- System Realization
- System Deployment and Use
- Systems Engineering Management
- Product and Service Life Management
- Systems Engineering Standards

(SEBoK, 2019)

Part 4 – Applications of Systems Engineering

- Application of the more general principles in Part 3 to specific types of systems, specifically products, services, enterprises, and systems of systems.
- Covers the application of SE to the development and deployment of products, services, enterprises, and systems of systems.
- Describes how to apply SE principles to different types of system context.
- Contains the following Knowledge Areas:
  - Product Systems Engineering
  - Service Systems Engineering
  - Enterprise Systems Engineering
  - Systems of Systems (SoS)
  - Healthcare Systems Engineering

(SEBoK, 2019)

Part 5 – Enabling Systems Engineering

- Discussion of the principles needed to organize to perform systems engineering at the organization, team, and individual levels.
- Discusses the enabling of SE at the individual, team, and business/enterprise levels and includes a discussion of ethics, team dynamics, and culture.
- Describes how to organize to enable the success performance of SE activities.
- Contains the following Knowledge Areas:
  - Enabling Businesses and Enterprises
  - Enabling Teams
  - Enabling Individuals

(SEBoK, 2019)

Part 6 – Related Disciplines

- Discussion of several disciplines relevant to systems engineering, such as project management, engineering management, design engineering including software engineering, and industrial engineering, but also including specialty engineering areas
- Focuses on the relationship of SE to other disciplines.
- Describes the relationships between SE and other disciplines.
- Contains the following Knowledge Areas:
  - Systems Engineering and Software Engineering
  - Systems Engineering and Project Management
  - Systems Engineering and Industrial Engineering
  - Systems Engineering and Specialty Engineering

(SEBoK, 2019)

Part 7 – Systems Engineering Implementation Examples

- Real-world examples of systems engineering achievements and challenges.
- Includes overviews of case studies and vignettes, which provide real-world examples of SE activities and provide links back to the concepts covered in the first 6 parts of the SEBoK
- Set of real-world examples of SE activities including
  - Case studies, which refer the reader to and summarize published examinations of the successes and challenges of SE programs,
  - Vignettes, which are brief, self-contained wiki articles
- Contains the following Knowledge Areas:
  - Matrix of Implementation Examples
  - Implementation Examples

(SEBoK, 2019)

Current Trends (continued)

- Mobile Internet- designates all technologies that provide full or partial access to the Internet using mobile devices such as smartphones or tablets
- Brain–computer interfaces-technologies used to directly connect external computer devices to the human brain. These devices allow individuals to interact with computers by thought
- Near field communication (NFC)- installed on payment cards and on mobile phones, which can carry out a transaction if placed a few centimeters from a properly-equipped receiver.

Current Trends (continued)

- Mobile robots-able to travel autonomously or semi-autonomously and that have the ability to influence their immediate environment are known as mobile robots.
- Quantum Computing- uses the laws of quantum mechanics to process large volumes of information much more efficiently than traditional computing.

Purpose of Cybersecurity (continued)

- Cyber security is protecting your internet and network based digital equipment and information from unauthorized access and alteration.
  - It is essential for families and parents to protect the children and family members from online fraud.
  - In terms of financial security, it is crucial to secure our financial information that can affect our personal financial status
  - Vital need for internet users to understand how to protect themselves from online fraud and identity theft.

THANK YOU

UNIVERSITY OF TEXAS ARLINGTON