Strategy for Developing Cybersecurity Workforce in CSTEC

: a Link between Lab-based Training and a Live-Fire Competition

Hanjin Park (Senior Researcher, Ph.D.), Soonjwa Hong (Principal Researcher, Ph.D.)

CSTEC (CyberSecurity Training and Exercise Center)

South Korea

fissea FEDERAL
CYBERSECURITY | INNOVATION . AWARENESS . TRAINING

CSTEC

Overview

- Need for cybersecurity workforce is increasing
- **CSTEC** (CyberSecurity Training and Exercise Center), Oct. 2014 in South Korea
- Two tracks
  - Trainings
    - Technical, Lab-based, Practice with a scenario, Chronological order
  - Exercise
    - CCE (Cyber Conflict Exercise): A live-fire attack-defense competition
- **Problem**
  - Skill-gap between trainees of Lab-based training and participants of CCE
- **Solution**
  - Re-design training courses
    - Work role using NICE Cybersecurity Workforce Framework (NCWF)
    - Level
      - Beginner, Intermediate, Advanced
      - Assessment attempt to assess trainees using KSAs unit [Survey]
    - Match the work role and the level between a trainee and a course

Lack of Cybersecurity Workforce

- Need for cybersecurity workforce is increasing
- Global
  - Lack of cybersecurity workforce: 1.8 Million people until 2022 year [1]
- Domestic (South Korea)
  - Lack of cybersecurity workforce: 9,854 people until 2020 year [2]

[1] A Frost & Sullivan Executive Briefing. Global Information Security Workforce Study. 2017.

[2] National Information Security White Paper, 2016. http://isis.kisa.or.kr/ebook/ebook2.html

History of CSTEC

- NISA (National Information Security Academy)
  - 2011, 3.4 DDoS attack, Nonghyup bank network failure
  - 2011, National cybersecurity master plan
  - Awareness trainings
    - basic essentials, knowledge-based, lecture-based, without practice
    - also have a special awareness training for executives (policy makers)

NISA 국가정보보안교육원

2012. 7.

- CSTEC (CyberSecurity Training and Exercise Center)
  - 2013, 3.20 Cyber terror
  - 2013, National cybersecurity comprehensive measures
  - About 1800 Employees in public sector / Year
  - Awareness trainings
  - **+ Lab-based trainings**
  - **+ Cyber attack defense competition**

CSTEC 사이버안전훈련센터

2014. 10.

Two Tracks

- Trainings
  - Awareness trainings
  - **Lab-based trainings**
    - Vulnerability scan/Penetration test training
    - Cybersecurity incident response training
      - Web servers
      - Government IT systems
      - ICS/SCADA system
      - Mobile/Wireless system
    - Comprehensive attacks and defense training
      - 20- people, a combination of multiple training contents
- Exercises
  - **Cybersecurity attack defense competition** (Cyber Conflict Exercise, CCE, Large scale, 200+ people, Live-fire competition, 2016 ~)

Lab-based Trainings

- Virtualized environment
- Instructor makes an attack to VMs or offers VM that is already compromised
- Trainees have to write on report at each step
- Workbook which contains the detail procedures is provided
- Some course contains role-play, some don’t
- **5 steps for cybersecurity incident response**

5 Steps for Cybersecurity Incident Response

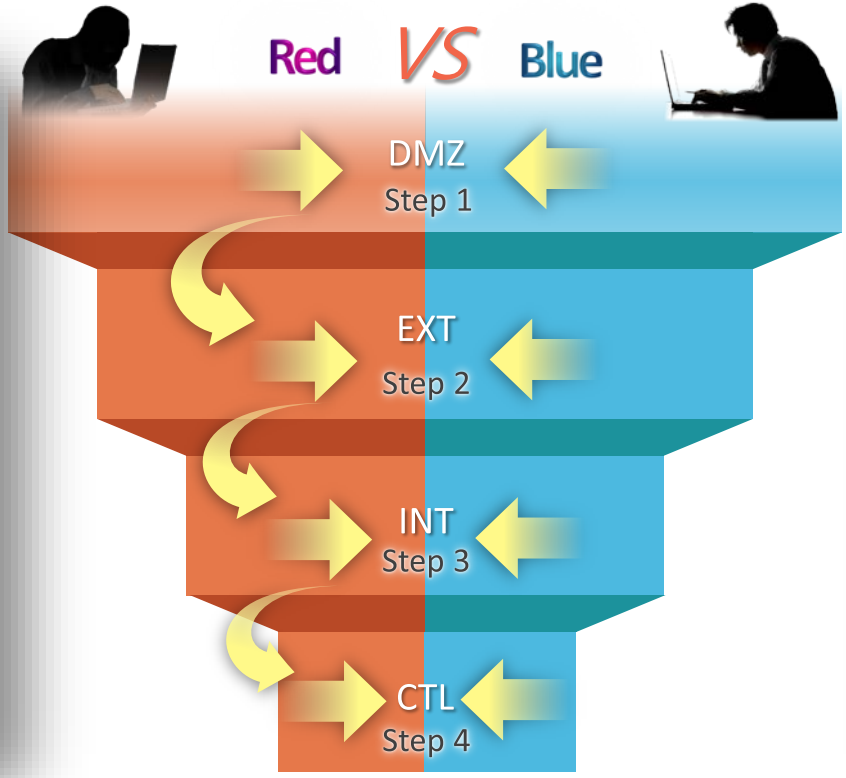
5 Steps	Process
Detection	Using various cybersecurity defense tools (e.g., IDS alerts, firewall, traffic log) to find cyber attack or to detect abnormal symptoms.
Initial Measure	Blocking networks from the internet connection, activating temporary service, and collecting data (forensic) from system and networks
Analysis	Identifying the malicious code and analyzing it statically and dynamically
Recovery	Removing the malicious code and recovering the system to the normal status
Security Enhancement	Updating new rules on the cybersecurity defense tools (e.g., IDS, firewall, network access control, MDM) to prevent the future attack that exploits the same vulnerabilities. Updating Anti-Virus with new rules.

CCE: Cyber Conflict Exercise

- Cybersecurity attack-defense exercise with multi-layer networks
- Live-fire, on-line quals and offline finals
  - After quals, select 10 Red teams, 16 Blue teams, (4 people in each team)
- Most participants are experts, 200+ people, 600+ VMs, 20+ Servers

Red team

- Realtime Attack
- Step-by-Step Intrusion (Pivoting)
- Realisitic Scenarios



Blue team

- Threat Hunting
- 5-step Response
  1. Detection
  2. Initial Reaction
  3. Analysis
  4. Recovery
  5. Security Enhancment
- Info. Sharing

Skill-gap between Trainees of Course and Participants of Competition

[Limitation 1]

- Trainee's work role is too general (coarse-grained work role)
- E.g. Android ransomware response course
  - Work role
    - "IT or Cybersecurity Manager/Officer of Public Sectors (includes governments)"

[Limitation 2]

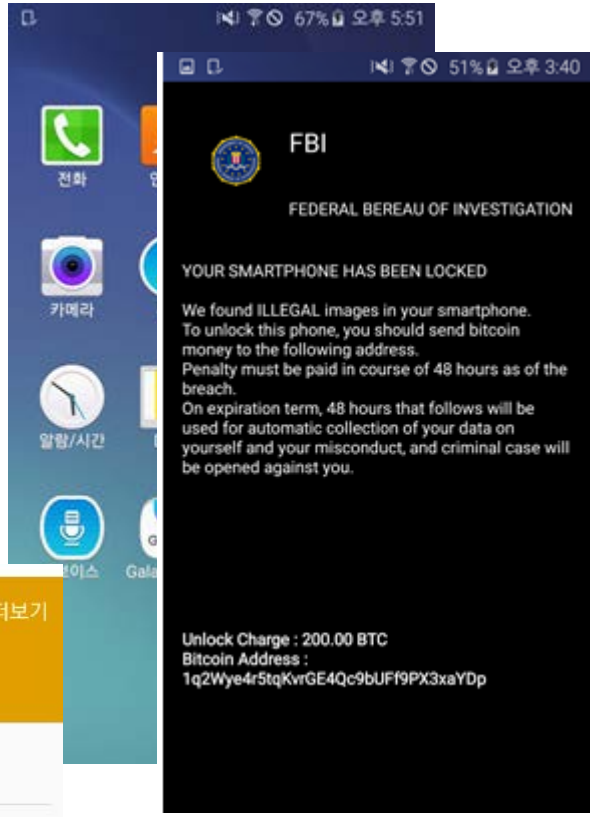
- There is no pre-test for trainees
- Trainee's levels are various

- Mismatched work role / level between trainees and courses

- Let's see them with an example
  - Android ransomware responses course (which I teach)

Android Ransomware Response Course

- Screenshots and pictures will be encrypted
- The victim downloaded Adobe flash players (malicious app) via 3rd party app market
- 5 steps to response

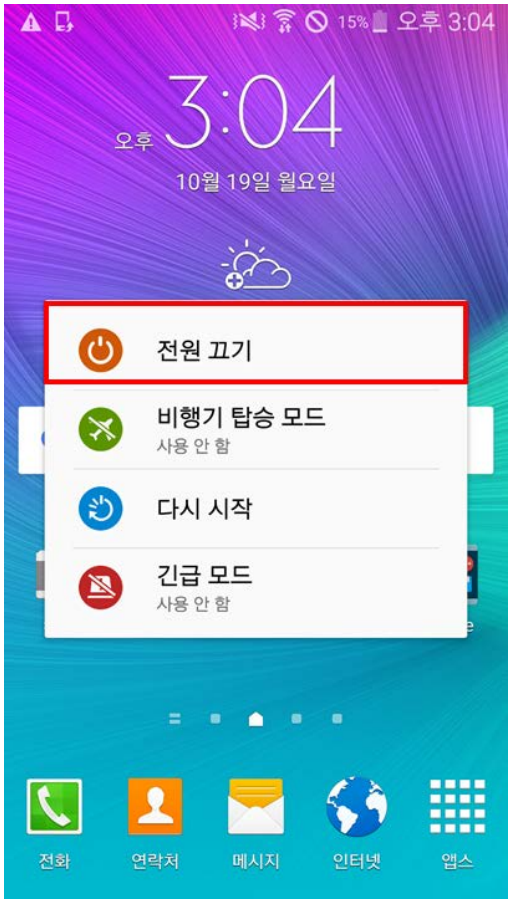


Step1: Detection

- Using various cybersecurity defense tools (e.g., IDS alerts, firewall, traffic log) to find cyber attack or to detect abnormal symptoms.
  - Smartphone screen has been locked!

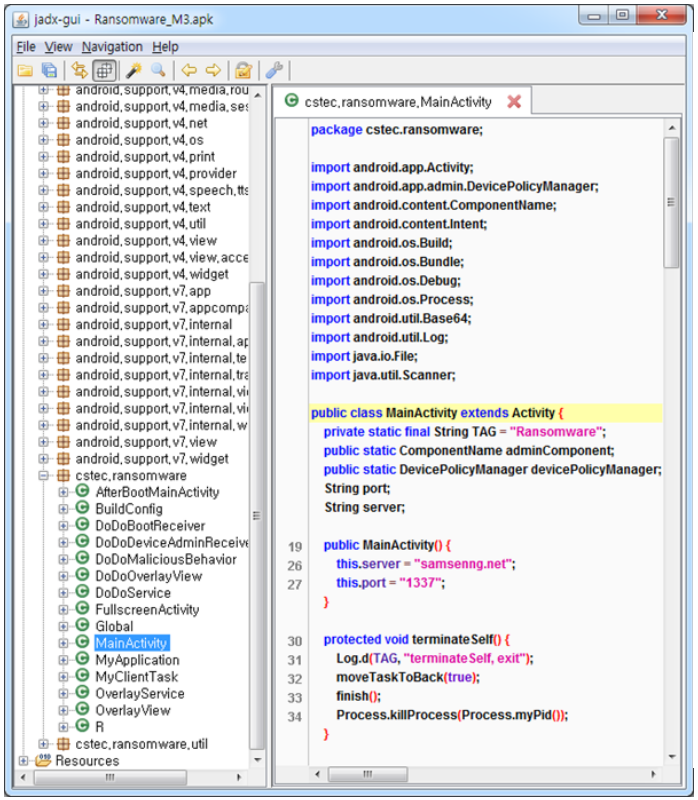
Step2: Initial Measure

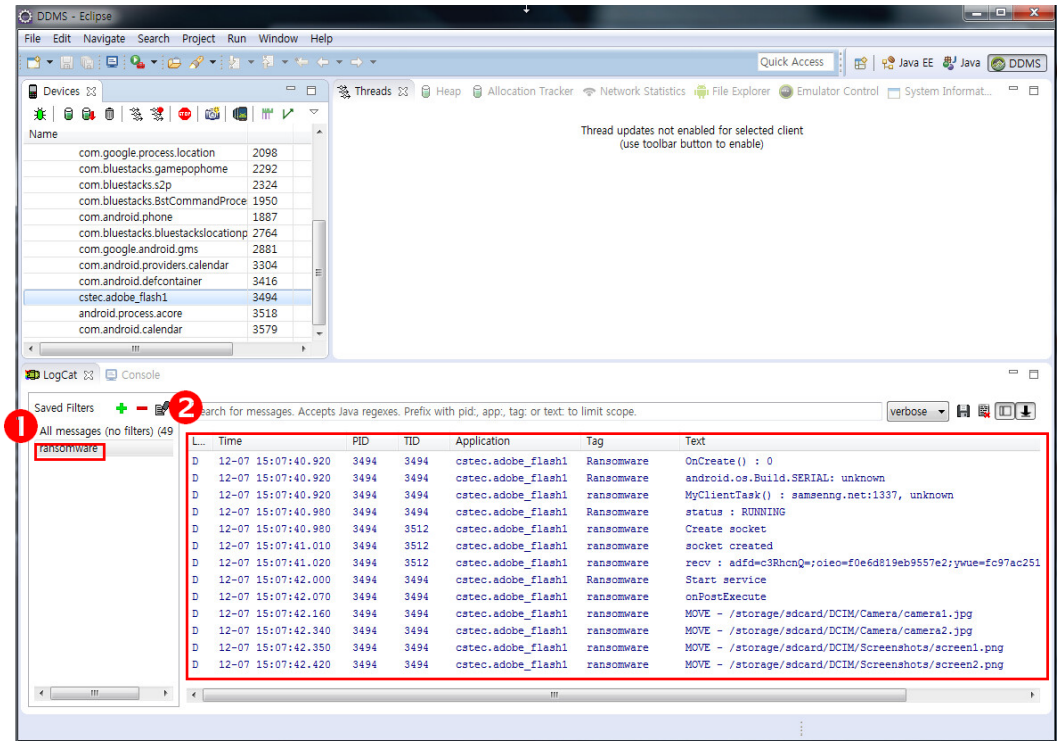
- Blocking networks from the internet connection, activating temporary service, and collecting data (forensic) from system and networks
  - Power Off
  - Image backup
    - There are several ways
    - Use ADB (Android Debug Bridge) backup command



Step3: Analysis

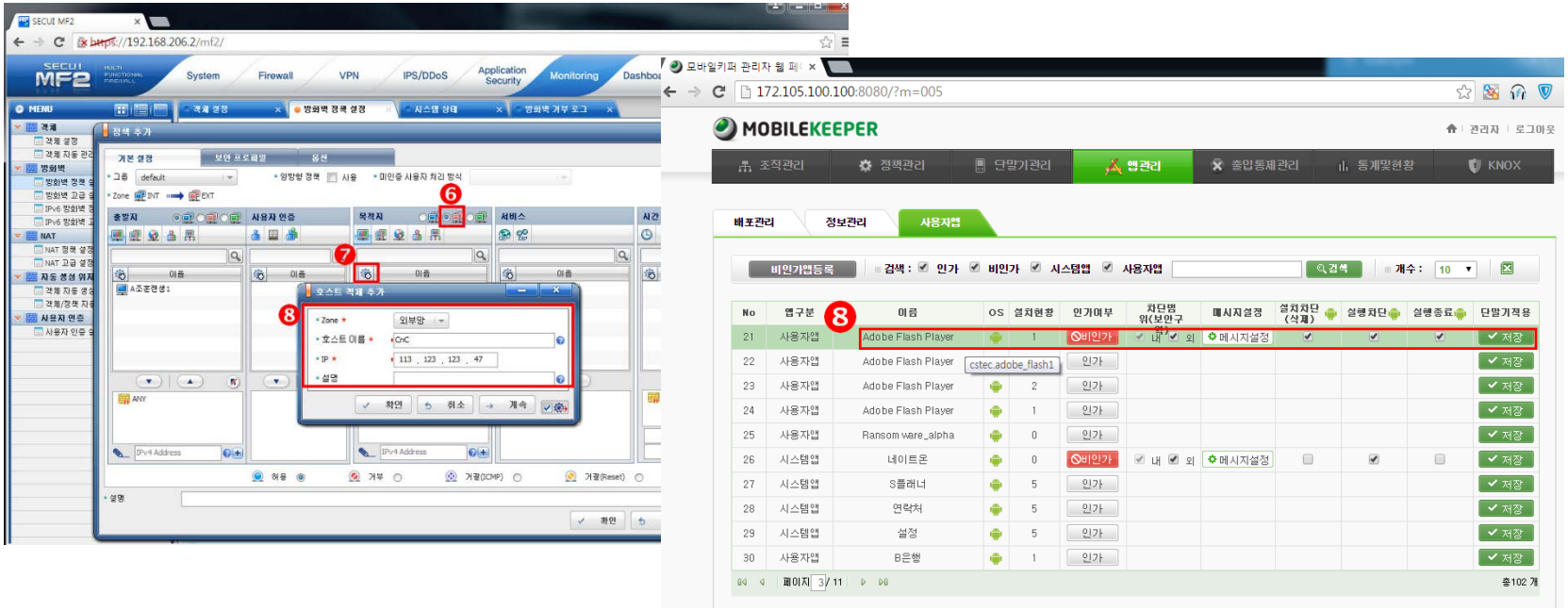
- Identifying the malicious code and analyzing it statically and dynamically
  - Collecting the malicious app
  - Decompile / Dissemble
  - Understand what malicious behaviors are





Step4: Recovery / Step5: Security Enhancement

- Removing the malicious code and recovering the system to the normal status
- Updating new rules on the cybersecurity defense tools (e.g., IDS, firewall, network access control, MDM) to prevent the future attack that exploits the same vulnerabilities. Updating Anti-Virus with new rules.

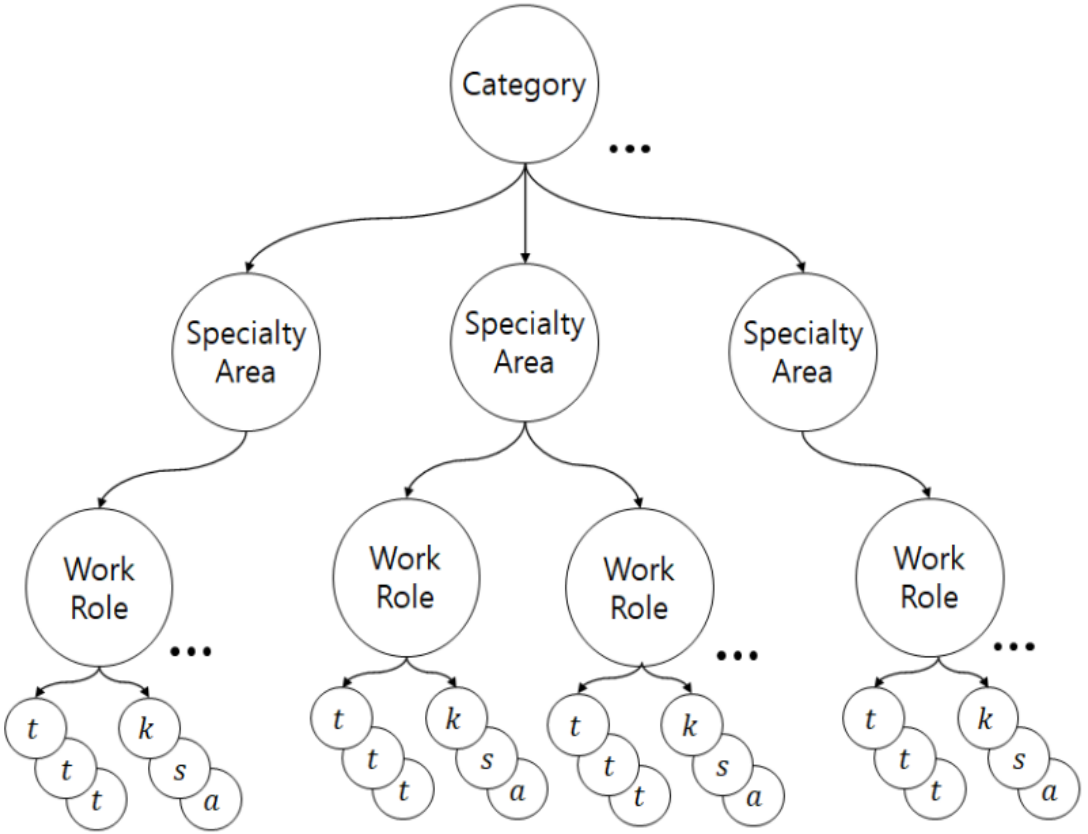


NICE Cybersecurity Workforce Framework (NCWF)

- 7 Categories, 33 Specialty Area, 52 Work Roles
- 1007 Tasks, 630 Knowledge, 374 Skills, 176 Availability

- 7 Categories
  - Securely Provision
  - Operate and Maintain
  - Oversee and Govern
  - Protect and Defend
  - Analyze
  - Collect and Operate
  - Investigate

- Specialty Area
- Work Role
- Task
- KSAs



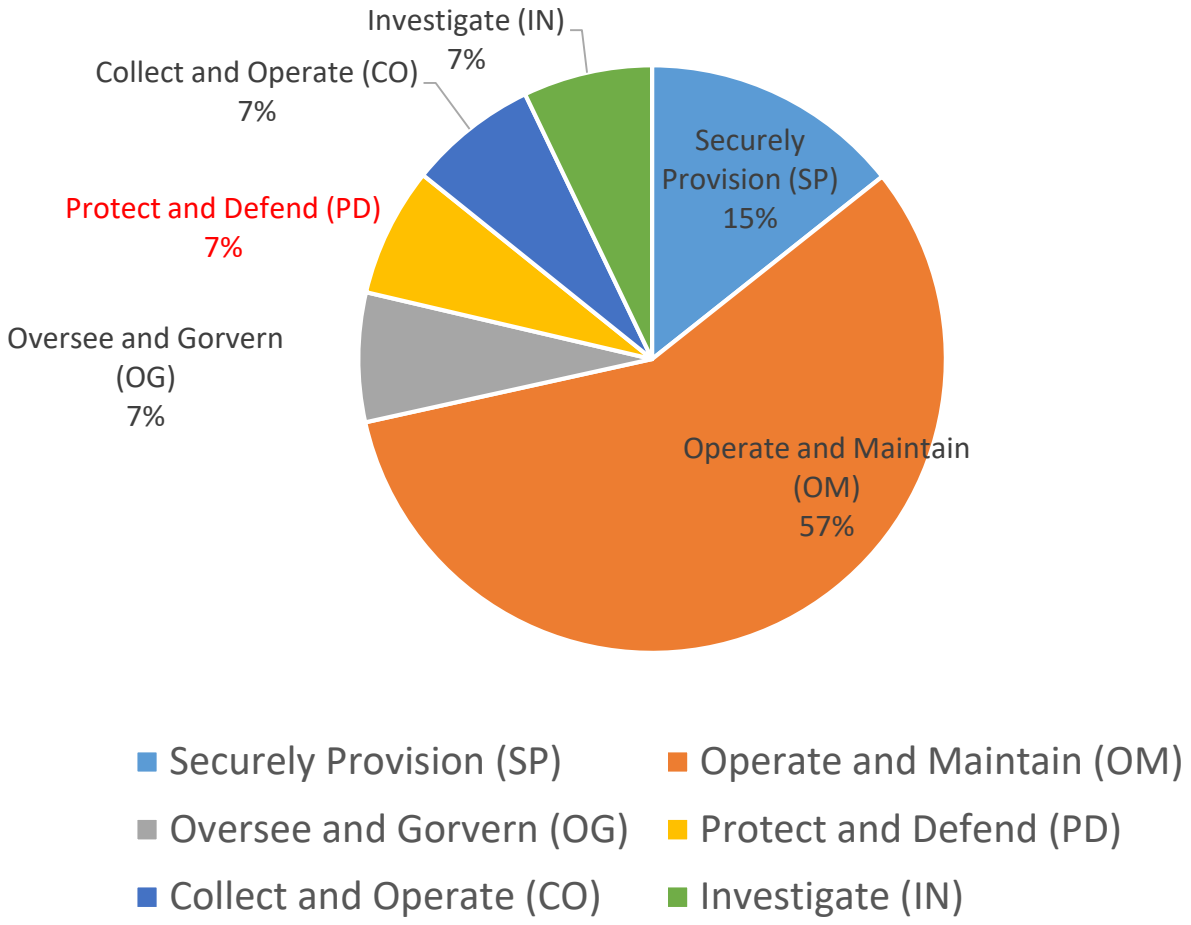
Adopting NCWF to Android Ransomware Response Course

5 Steps	Process	Category	Specialty	Work Role
Detection	Using various cybersecurity defense tools (e.g., IDS alerts, firewall, traffic log) to find cyber attack or to detect abnormal symptoms.	Protect and Defend	Incident Response	Cyber Defense Incident Responder [1]
Initial Measure	Blocking networks from the internet connection, activating temporary service, and collecting data (forensic) from system and networks			
Analysis	Identifying the malicious code and analyzing it statically and dynamically			
Recovery	Removing the malicious code and recovering the system to the normal status			
Security Enhancement	Updating new rules on the cybersecurity defense tools (e.g., IDS, firewall, network access control, MDM) to prevent the future attack that exploits the same vulnerabilities. Updating Anti-Virus with new rules.			

[1] Investigates, analyzes, and responds to cyber incidents within the network environment or enclave

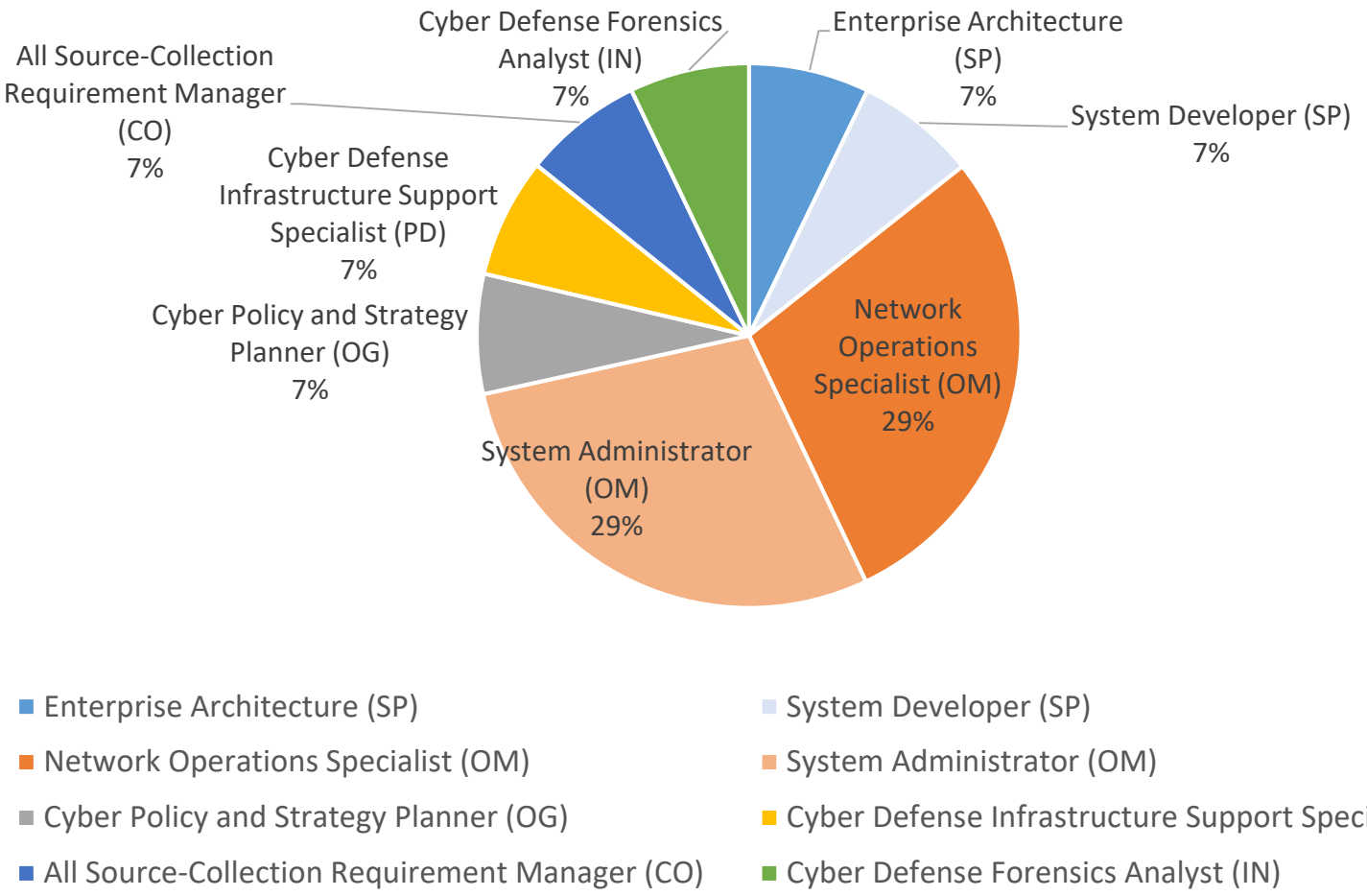
Various Categories

- Participants of the survey: Android ransomware response course in Nov/26/2018 – Nov/28/11, 14 people
- Category: Protect and Defend (only 7%)



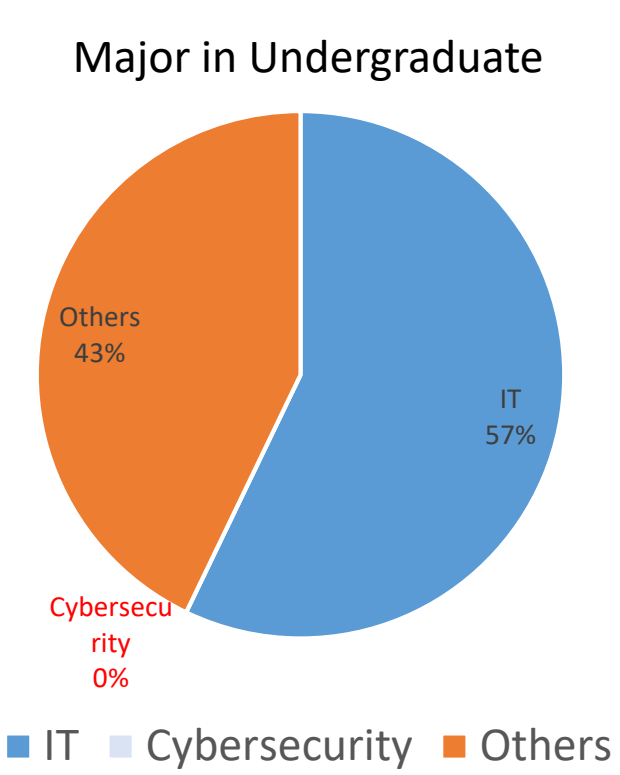
Various Work Roles

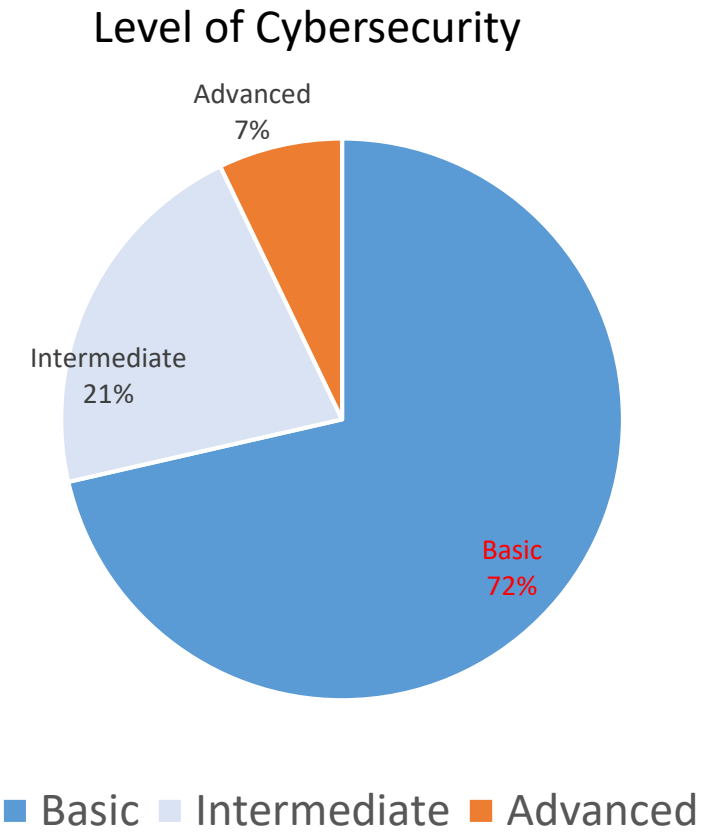
- Participants of the survey: Android ransomware response course in Nov/26/2018 – Nov/28/11, 14 people
- Work role: Cyber Defense Incident Response (0%)



Various Levels

- Participants of the survey: Android ransomware response course in Nov/26/2018 – Nov/28/11, 14 people
- Level: Basic (72%), Intermediate (21%), Advanced (7%)





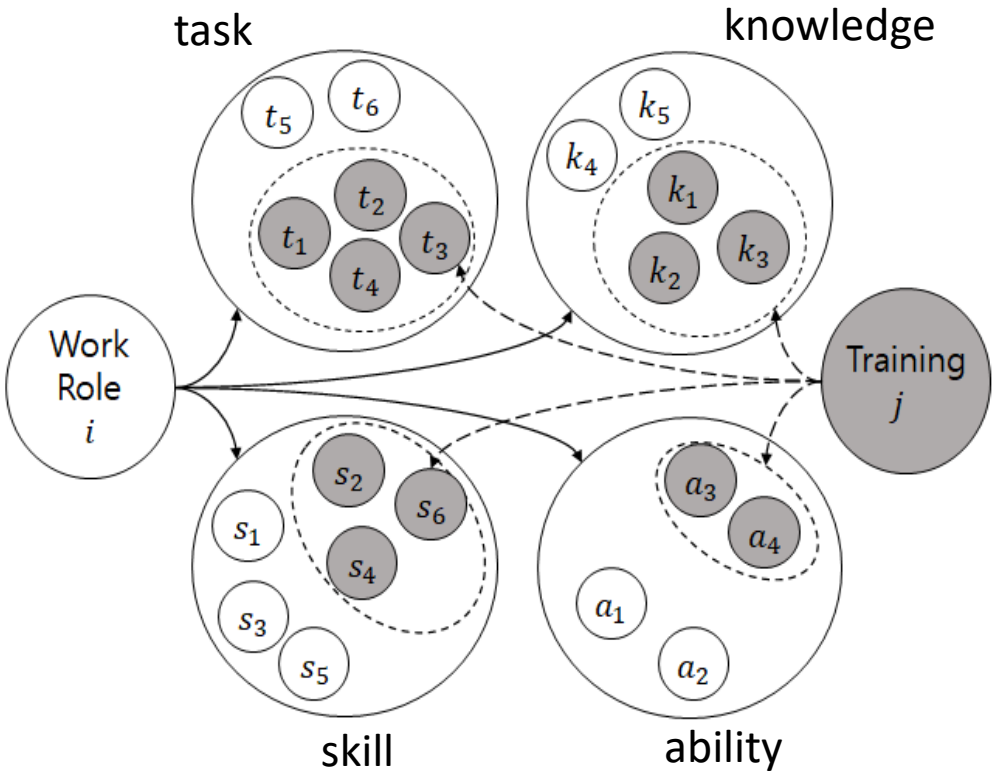
Matching Work Role / Level

- Guideline for Course Enrolment
  - **Work role**
    - Analyzing the trainee's work role before he or she enrolled the class using NCWF
    - Notifying specific work roles of the course
  - **Level**
    - Design three different courses depending on levels
      - Beginner, Intermediate, Advanced
        - In the android ransomware response course,
          - Beginner: A version of no encryption, just move files
          - Intermediate: Encryption key which is in a malicious app
          - Advanced: Never decrypt version (because key had been removed)
    - Pre-test to identify trainee's level

- How can we assess a trainee's level?

About Assessment of Trainee's Level

- [Pilot Study]
  - Course: Android ransomware response course
  - Work role: cyber defense incident role (CIR)
  - Mapping KSAs of CIR to the course
  - Derive the related KSAs from the course
  - Unit assessment of trainees' using the selected KSAs
  - Classify the level according to range of points



Selected Knowledges

- A survey: Android ransomware response course in Nov/26/2018 – Nov/28/11, 14 people
- 10 Knowledge are selected

ID	Knowledge
K0001	Knowledge of computer networking concepts and protocols, and network security methodologies.
K0005	Knowledge of cyber threats and vulnerabilities.
K0021	Knowledge of data backup and recovery.
K0033	Knowledge of host/network access control mechanisms (e.g., access control list, capabilities lists).
K0041	Knowledge of incident categories, incident responses, and timelines for responses.
K0042	Knowledge of incident response and handling methodologies.
K0046	Knowledge of intrusion detection methodologies and techniques for detecting host and network-based intrusions.
K0070	Knowledge of system and application security threats and vulnerabilities (e.g.,malicious code).
K0259	Knowledge of malware analysis concepts and methodologies.
K0332	Knowledge of network protocols such as TCP/IP, Dynamic Host Configuration, Domain Name System (DNS), and directory services.

Selected Availabilities and Skills

- A survey: Android ransomware response course in Nov/26/2018 – Nov/28/11, 14 people
- 4 Skills and 1 Ability are selected

ID	Skill
S0003	Skill of identifying, capturing, containing, and reporting malware
S0047	Skill in preserving evidence integrity according to standard operating procedures or national standards.
S0077	Skill in recognizing and categorizing types of vulnerabilities and associated attacks.
S0079	Skill in protecting a network against malware. (e.g., NIPS, anti-malware, restrict/prevent external devices, spam filters).

ID	Ability
A0128	Ability to apply techniques for detecting host and network-based intrusions using intrusion detection technologies

Self-Assessment using KSAs

- Self-assessment checking value
  - Select from 0 to 5 for each equation
    - 0: Unexperienced
    - 1: Having Basic knowledge
    - 2: Beginner (Limited experience, Need professionals' help to do problem solving)
    - 3: Intermediate (Possible to adopt practical usage, Need occasional professionals' help to do problem solving)
    - 4: Expert (problem solving without external help, subject to be inquired from others)
    - 5: Professionals (certificated professionals)

- Trainee selects one of the five choices

Results of Self-Assessment (1/2)

- Android ransomware response course in Nov/26/2018 – Nov/28/11, 14 people
  - One trainee did not answer the KSAs question
  - Two times survey:
  - Before taking the course, After taking the course

	K0001	K0005	K0021	K0033	K0041	K0042	K0046	K0070	K0259	K0332
User01	0	1	0	0	1	1	0	0	0	0
User02	4	4	4	4	4	4	4	4	4	4
User03	0	0	0	0	0	0	0	0	0	0
User04	1	2	1	1	2	2	1	1	1	2
User05	1	1	2	2	2	2	2	2	2	2
User06	0	0	0	0	0	0	0	0	0	0
User07	1	2	3	2	2	2	2	2	3	2
User08	1	1	0	1	1	1	0	1	0	1
User09	1	2	1	1	1	1	1	1	1	1
User10	0	1	0	0	0	0	0	0	0	0
User11	3	3	3	2	2	3	2	2	1	2
User12	0	0	1	2	0	0	2	0	0	3
User13	1	1	2	1	1	1	1	1	1	2

	K0001	K0005	K0021	K0033	K0041	K0042	K0046	K0070	K0259	K0332
User01	1	2	1	1	2	2	1	1	1	1
User02	4	4	4	4	4	4	4	4	4	4
User03	1	2	1	1	1	2	1	1	1	2
User04	3	3	3	3	3	3	3	3	3	3
User05	2	3	3	3	3	3	3	3	3	3
User06	3	3	3	3	3	3	3	3	3	3
User07	4	4	4	4	3	4	4	4	4	3
User08	2	3	2	2	3	3	1	2	1	2
User09	2	2	2	2	2	2	2	2	2	2
User10	3	4	1	3	4	4	3	3	2	2
User11	3	3	4	3	3	3	3	3	2	3
User12	3	3	3	4	3	3	4	3	3	5
User13	2	2	2	1	2	2	2	2	2	2

Knowledge

Results of Self-Assessment (2/2)

- Android ransomware response course in Nov/26/2018 – Nov/28/11, 14 people
  - One trainee did not answer the KSAs question
  - Two times survey
  - Before taking the course, After taking the course

	S0003	S0047	S0077	S0079
User01	0	0	0	0
User02	4	3	4	4
User03	0	0	0	0
User04	1	1	1	1
User05	2	2	2	2
User06	0	0	0	0
User07	2	2	2	2
User08	0	0	0	0
User09	1	1	1	1
User10	0	0	0	0
User11	1	1	1	2
User12	0	0	0	0
User13	1	1	1	1

	S0003	S0047	S0077	S0079
User01	1	0	0	0
User02	4	3	4	4
User03	1	1	1	2
User04	3	3	3	2
User05	3	3	3	3
User06	3	3	3	3
User07	3	3	2	3
User08	1	1	1	1
User09	3	3	3	2
User10	2	2	2	3
User11	2	2	2	3
User12	3	3	3	3
User13	2	2	2	2

Skill

	A0128
User01	0
User02	4
User03	0
User04	1
User05	2
User06	0
User07	2
User08	0
User09	1
User10	0
User11	2
User12	0
User13	1

	A0128
User01	1
User02	3
User03	2
User04	2
User05	3
User06	3
User07	3
User08	2
User09	2
User10	3
User11	3
User12	3
User13	2

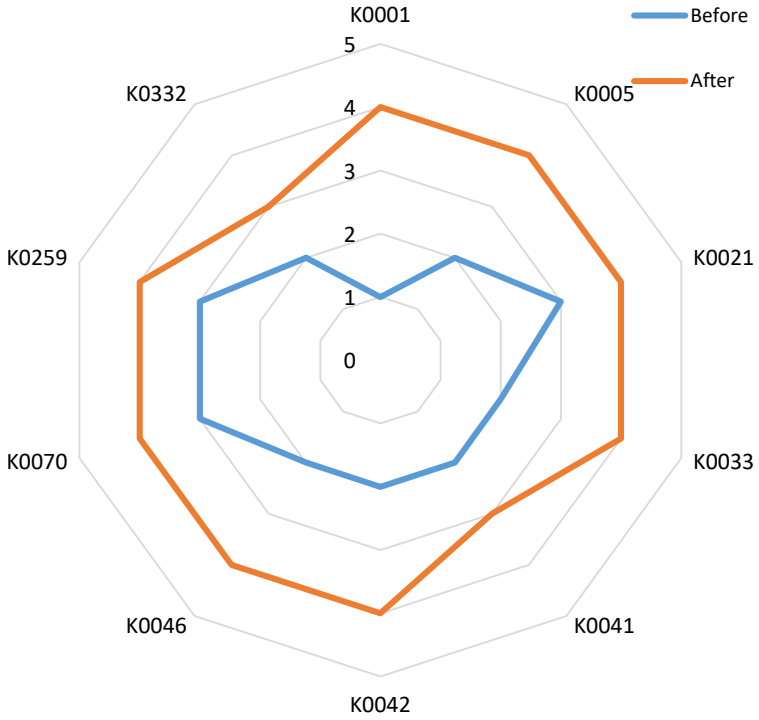
Ability

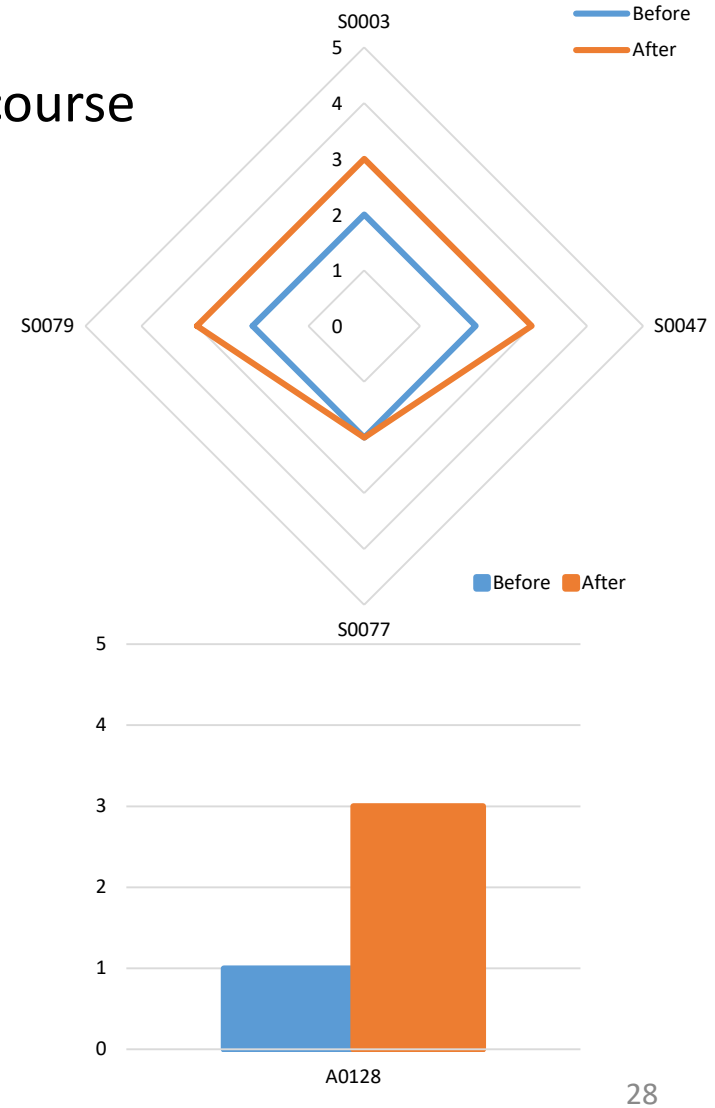
Limitation of Self-Assessment

- An assessment method
  - [Simple math]
    - 15 items (10 Knowledge, 4 Skills, and 1 Ability) with range [0, 5]
    - Summation of checking values
      - Sum in [0, 75] : Possible
      - Sum in [0, 25] ➔ Beginner Level
      - Sum in [25, 50] ➔ Intermediate Level
      - Sum in [50, 75] ➔ Advanced Level
- [Limitation] Since the result of self-assessment is subjective, it is difficult to make range for leveling such as basic, intermediate, advanced
- Assessment of trainees is still open question!
- However, we can see the improvement of trainee after taking this course.

Assessment of a Trainee (Before/After Comparison)

- Android ransomware response course in Nov/26/2018 – Nov/28/11, 14 people
- Before taking the course, After taking the course
- A user
  - User7





Future Work

- For level-tests
  - Design pre-test for each course
    - E.g., Unit test using KSAs
    - Classify the trainees as the one of three levels, such as Beginner, Intermediate, Advanced

- Verify and research the effects of this with more trainees

Conclusion

- CSTEC
  - Two tracks
    - Lab-based trainings
    - Cybersecurity attack defense competition
- Skill-gap between participants of Lab-based trainings and competitions
  - Mismatched work role and level between trainees and courses
- Solutions

  [Case Study] Android ransomware response course

  1. Matching work role between trainees and courses
  2. Matching level between trainees and courses

Thank you

Q&A

hjpark001@nsr.re.kr