Security Assessment Technique for SDN

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Contents

1. Introduction (1/2)

- SDN is rapidly moving from vision to reality
  - Host of SDN-enabled devices in development and production
  - The combination of separated **control** and **data plane functionality** and **programmability** in the network have found their commercial application in cloud computing and virtualization technology
- The SDN architecture can be exploited to enhance network security
  - Provision of highly reactive security monitoring, analysis and response time
  - The **central controller** is key to this system
    - Deploy traffic analysis or anomaly-detection

%SDN : Software Defined Networks

1. Introduction (2/2)

- However, the same attributes of centralized control and programmability associated with the SDN platform introduce network security challenges
  - An increased potential for Denial-of-Service attacks
    - Centralized controller and flow-table limitation in network device
  - Another issue of concern based on open programmability of the network is trust
    - Between applications and controllers
    - Between controllers and network devices
- An Assessment technique for SDN security is required

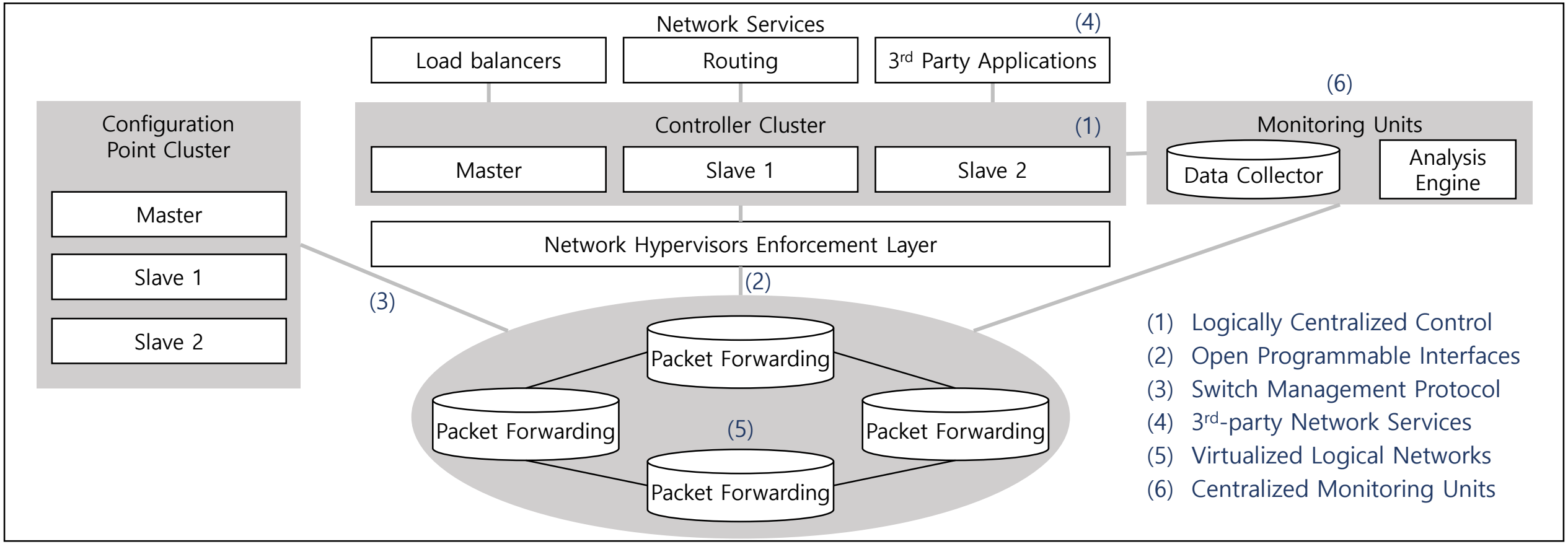
2. Security Analysis of SDN (1/4)

- The basic properties of a security communications network
  - Confidentiality
  - Integrity
  - Availability of information
  - Authentication
  - Non-repudiation

  → Secure data, network assets and communications transactions

2. Security Analysis of SDN (2/4)

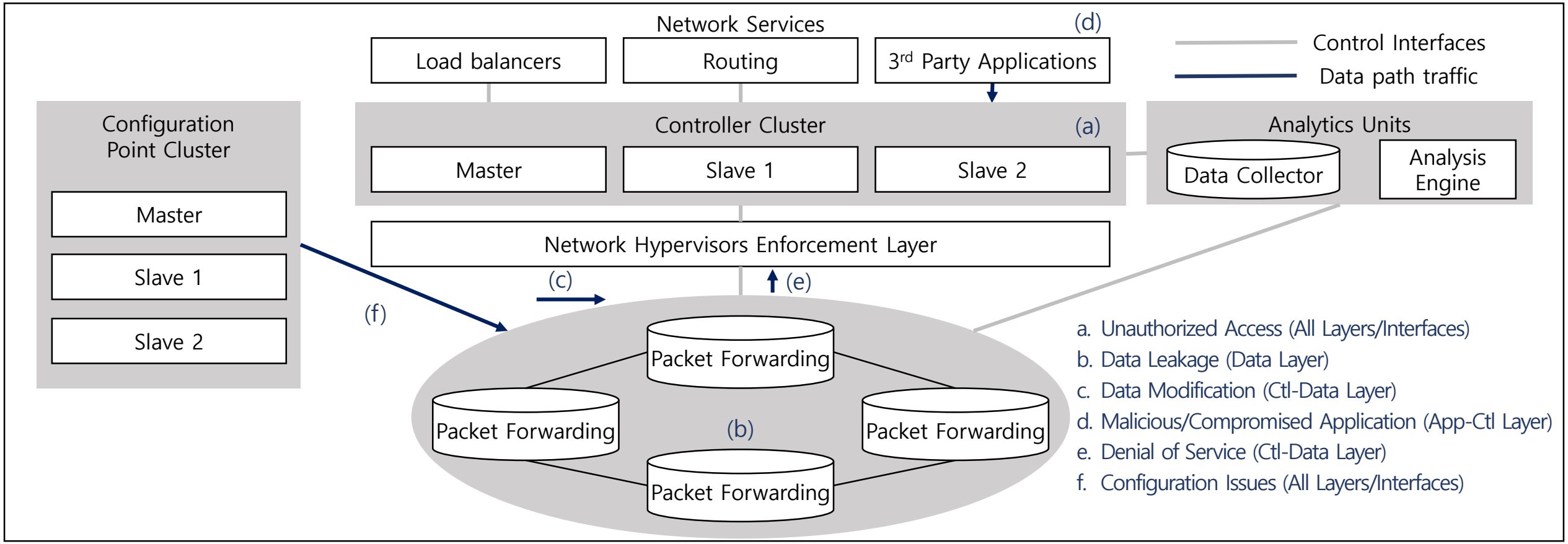
- SDN Characteristics



'A Survey of Security in Software Defined Networks', IEEE Communications Surveys & Tutorials, 2015.

2. Security Analysis of SDN (3/4)

- SDN Potential Attack and Vulnerabilities



'A Survey of Security in Software Defined Networks', IEEE Communications Surveys & Tutorials, 2015.

2. Security Analysis of SDN (4/4)

- Categorization of Security Issues

Security Issue/Attack	SDN Layer Affected or Targeted				
	Application Layer	App-Ctl Interface	Control Layer	Ctl-Data Interface	Data Layer
Unauthorized Access e.g. • Unauthorized Controller Access/Controller Hijacking • Unauthorized/Unauthenticated Application	 X	 X	X X	X	X
Data Leakage e.g. • Flow Rule Discovery (Side Channel Attack on Input Buffer) • Credential Management (Keys, Certificates for each Logical Network) • Forwarding Policy Discovery (Packet Processing Timing Analysis)			 X	 X	X X X
Data Modification e.g. • Flow Rule Modification to Modify Packets (Man-in-the-middle attack)			X	X	X
Malicious/compromised Applications e.g. • Fraudulent Rule Insertion	X	X	X		
Denial of Services e.g. • Controller-Switch Communication Flood • Switch Flow Table Flooding			X	X	X X
Configuration Issues e.g. • Lack of TLS(or other Authentication Technique) Adoption • Policy Enforcement • Lack of Secure Provisioning	X X X	X X X	X X X	X X	X X
System Level SDN Security e.g. • Lack of Visibility of Network State			X	X	X

'SDN Security: A Survey', IEEE SDN for Future Networks and Services, 2013.

3. Security Assessment Technique for SDN

3.1 Taxonomy of issues

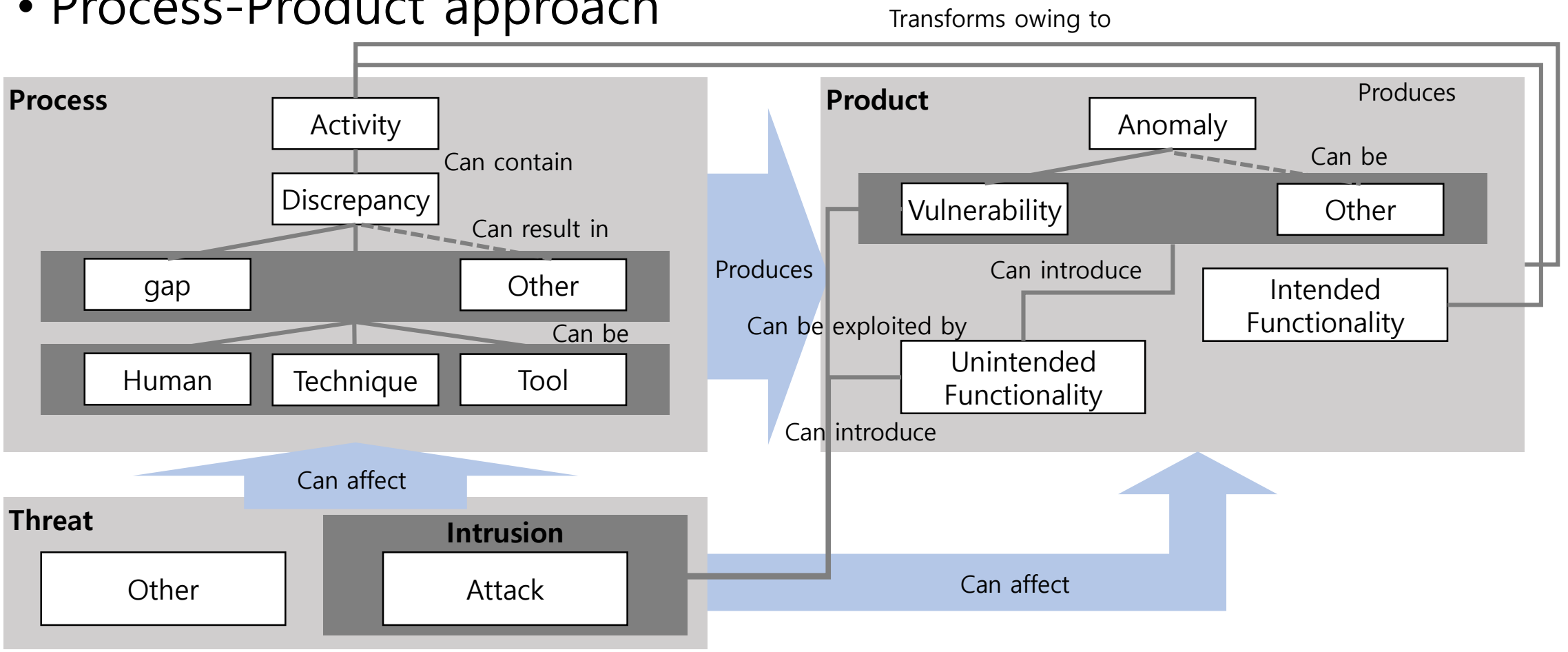
3.2 Assessment Technique

3.1 Taxonomy of issues (1/2)

- The key idea in security assessment is using **process-product approach**
  - In determining the **possible problems**, inconsistencies during **process implementation** and obtaining of the **products**
  - One of the fundamental concepts behind the idea of the approach is the concept of '**gap**'
    - 'gap' could be defined as **a set of discrepancies** of any single process that can introduce some **anomalies** (e.g. **vulnerabilities**) in a product and/or cannot reveal (and eliminate) existing anomalies in a product

3.1 Taxonomy of issues (2/2)

- Process-Product approach



"Cyber Security Lifecycle and Assessment Technique for FPGA-based I&C systems", Design & Test Symposium, 2013

3.2 Assessment Technique

- Each '**gap**' should be represented in a form of formal description
  - To perform the description, the most convenient is **IMECA** technique
    - **Intrusion Modes and Effects Criticality Analysis**
    - **Modification to FMECA** technique that takes into account possible intrusions into the system
    - During the Security Assessment, IMECA can be used in addition to standardized FMECA for **safety-related domains**
      - each **vulnerability** can become a **failure** in a case of **intrusion** into such systems
  - Each identified gap can be represented by a single local IMECA table and each discrepancy inside the gap can be represented by a single row in that local IMECA table

4. Case study of Security Assessment Technique (1/3)

- Based on Categorization of SDN Security Issues from **'SDN Security: A Survey'**, it is possible to choose several types of intrusions
  - **Controller hijacking**
  - **Man-in-the-middle**
  - **Denial of Service**
- Following table shows application of IMECA technique for analysis of theses intrusions

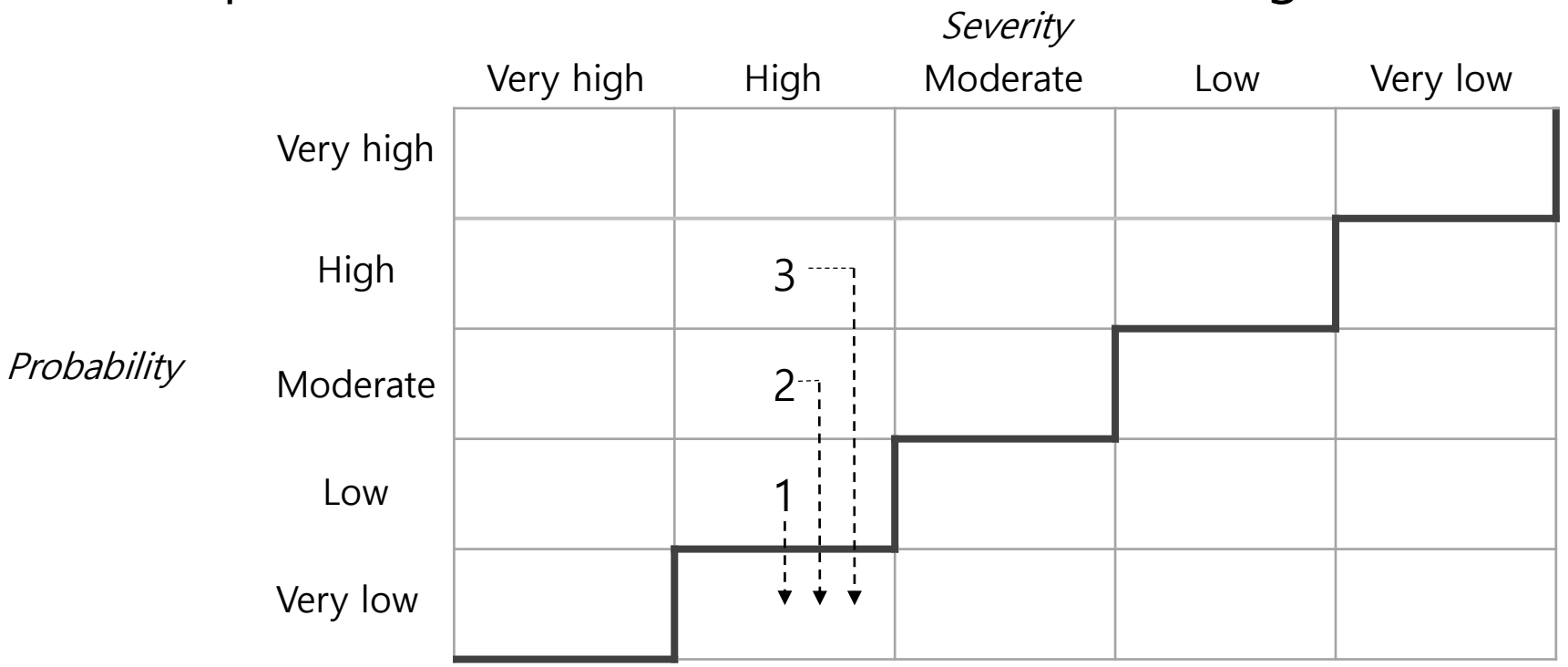
4. Case study of Security Assessment Technique (2/3)

- Intrusion Modes and Effects Criticality Analysis

GAP No	Attack mode	Attack nature	Attack cause	Occurrence Probability	Effect Severity	Type of effects				
						Application Layer	App-Ctl Interface	Control Layer	Ctl-Data Interface	Data Layer
1	Controller hijacking	Active	• Weak authentication	Low	High	-	-	• Gain access to network resource • Manipulate the network operation		
2	Main-in-the middle	Active	• Weak Authentication • Weak confidentiality	Moderate	High	-	-	• Have control over the entire system • Insert/Modify flow rules in the network devices • Allow packets to be steered through the network to the attacker's advantage		
3	Denial of Service	Active	• Weak protection • Resource limitation of flow table	High	High	-	-	• Lead to fraudulent rule insertion and rule modification		

4. Case study of Security Assessment Technique (3/3)

- Criticality matrix (Adapted from ISO 31000:2009)
  - Each of the numbers inside the matrix row number of IMECA table
  - Acceptable values of risks are below the diagonal



5. Conclusion

- A secure SDN does not exist
  - Hidden vulnerabilities are still possible in SDN
  - Security Assessment should be perceived as a repeatable process
- Assurance of SDN security is not possible without taking in to account all specific features of technologies in use
  - In addition to improving SDN, it is necessary to focus on developing rules and best practices that establish and maintain security of SDN

6. Future work

- Compare the IMECA Assessment technique with other methodology such as STRIDE
- Compare SDN Security between various Controllers
  - ONOS
  - OpenDaylight
  - ROSEMARY
  - Ryu
  - SE-Floodlight
- Research and Categorize Security solutions and SDN Security Enhancement
- Recommend Best Practices

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