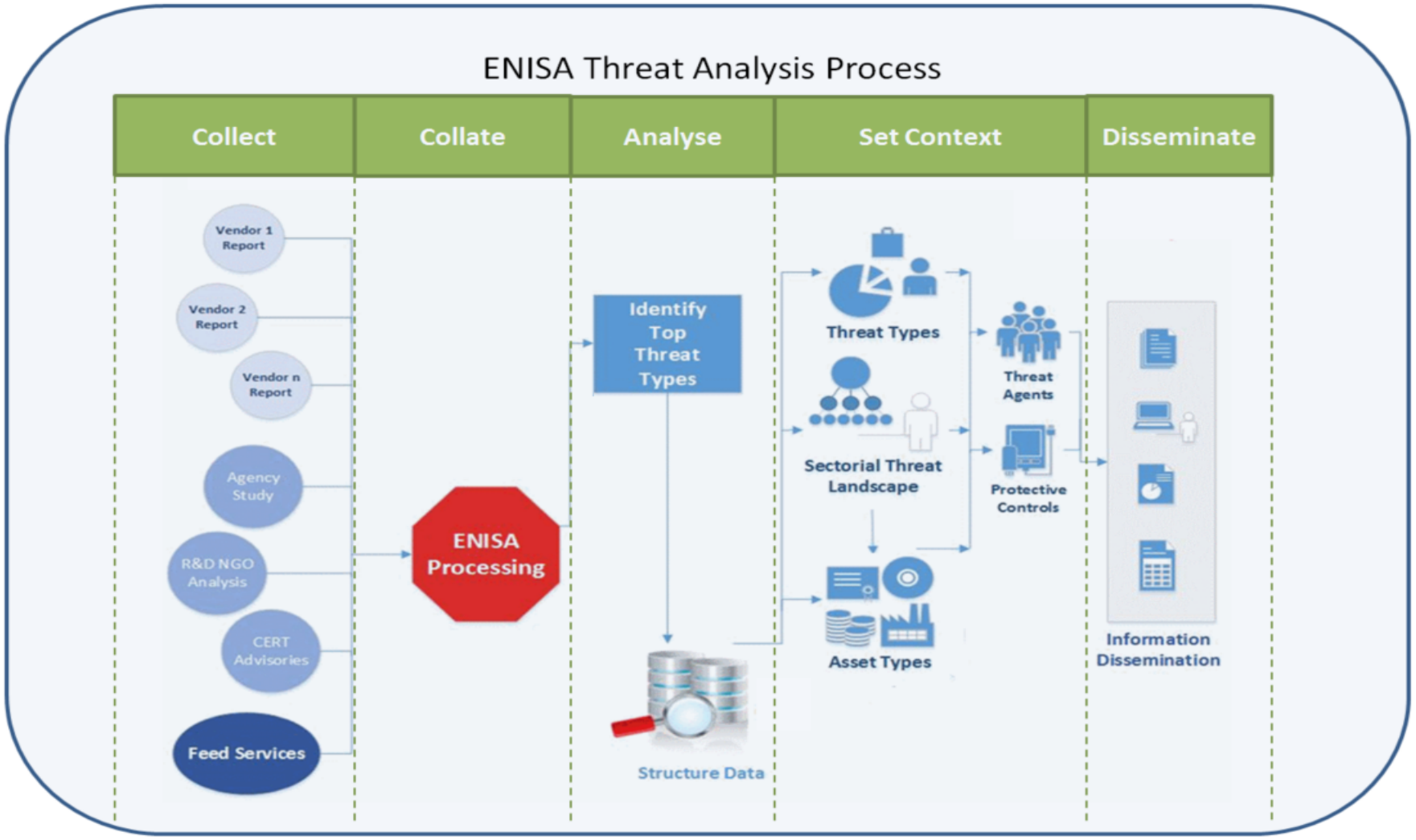
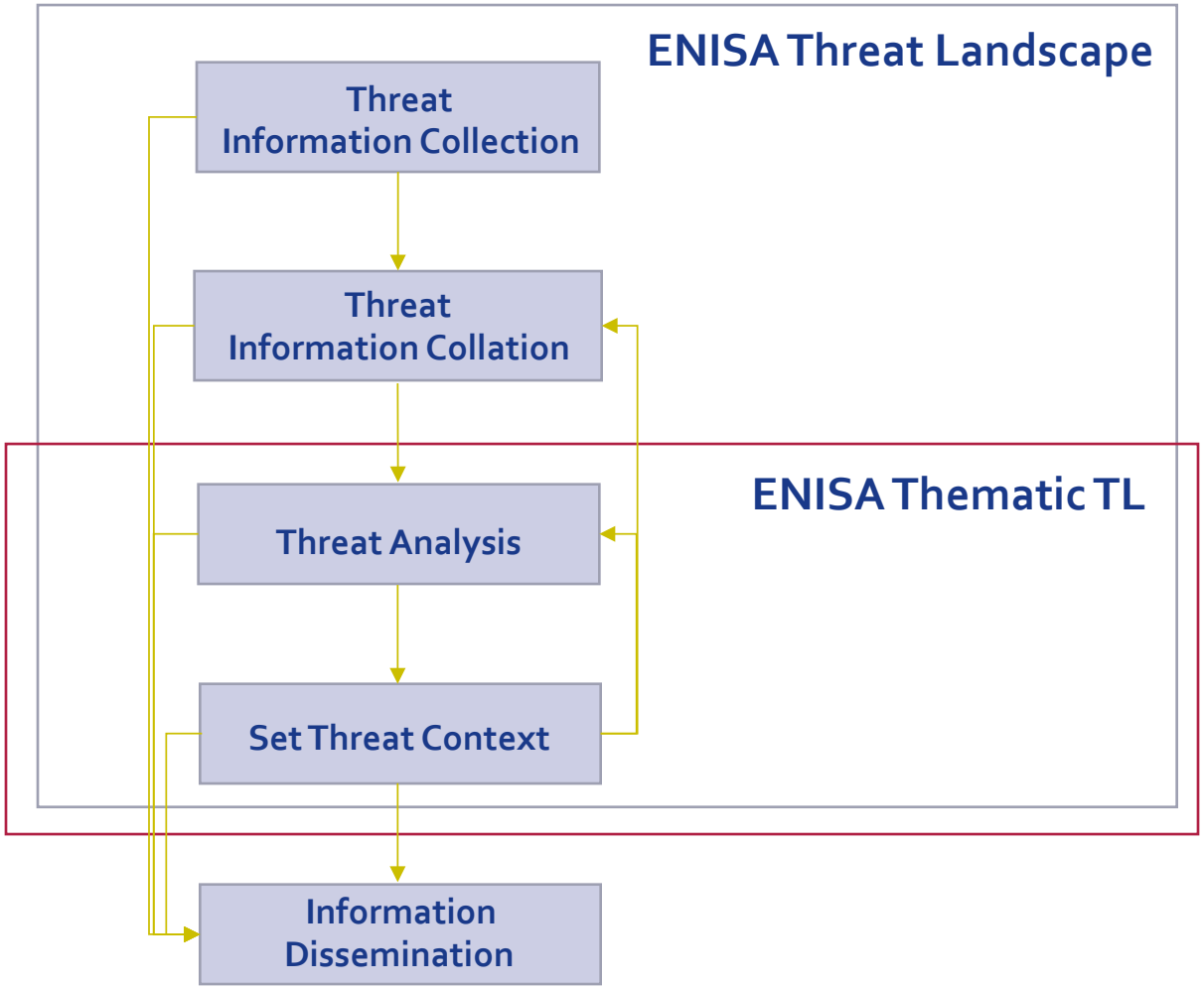
ENISA TTL SDN/5G

Adrián Belmonte|1st International Workshop on 5G Security Standardization| Sophia Antipolis| 16 June 2016

What is ENISA Threat Landscape



From Threat Info to Intel…



Find reliable sources

Isolate and relate similar information

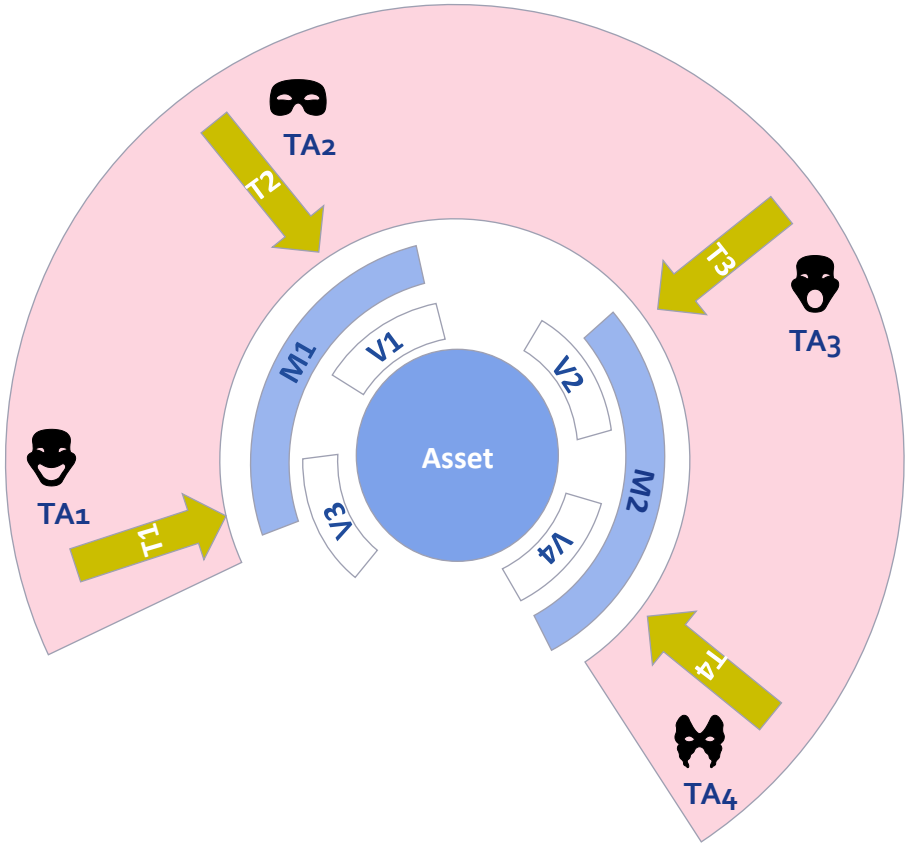
Evaluate findings and decide what to take on board

Find out practices, issues, vulnerabilities, risks, etc.

THE TOP THREATS EVOLUTION

Top Threats 2014	Assessed Trends 2013	Top Threats 2015	Assessed Trends 2014	Change in ranking
1. Malicious code: Worms/Trojans		1. Malware		
2. Web-based attacks		2. Web-based attacks		
3. Web application /Injection attacks		3. Web application attacks		
4. Botnets		4. Botnets		
5. Denial of service		5. Denial of service		
6. Spam		6. Physical damage/theft/loss		
7. Phishing		7. Insider threat (malicious, accidental)		
8. Exploit kits		8. Phishing		
9. Data breaches		9. Spam		
10. Physical damage/theft /loss		10. Exploit kits		

Cyber-threats: what is it?



ETL Scope

TA Threat Agent

T Threat

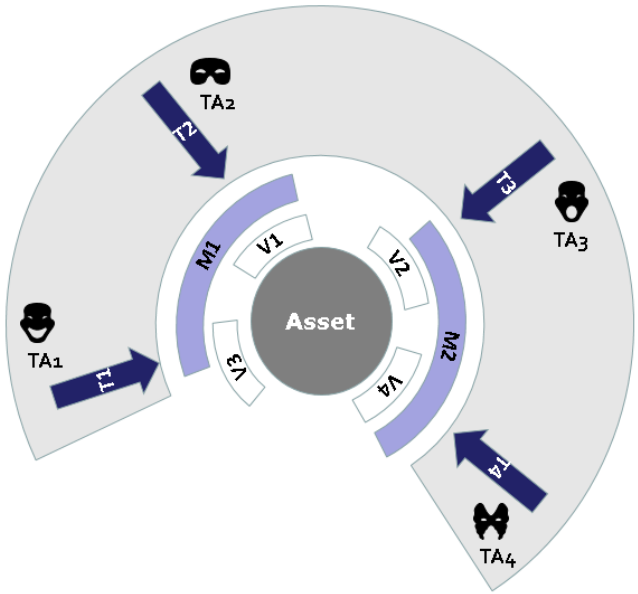
V Vulnerability

M Measure

The exposure of an assets to threats

What are the parts?

- Assets
- Vulnerabilities
- Controls
- Threats
- Threat Agents
- Attack methods (vectors)



…**and** interconnections thereof

is **Threat Intelligence!**

Why this work on 5G/SDN

- 5G represents the next major phase of mobile telecommunication systems and network, aiming at extreme broadband and ultra-robust, low latency connectivity
- Strong interconnection and key enabler for the development of future technologies (IoT, Smart cities, Intelligent transportation…)
- 5G will be driven by the influence of Software Defined Networking (SDN) and Network Function Virtualization (NFV).
- The key concept that underpins SDN is the logical centralization of network control functions by decoupling the control and packet forwarding functionality of the network
- Needed to provide a comprehensive account of the emerging threat SDN/5G landscape:
  - By identifying related network assets and the security threats, challenges and risks arising for these assets.
  - Review and identify existing security mechanisms and good practices for SDN/5G/ NFV

What 5G network architecture will bring

- Integrate multiple radio access technologies in licensed and unlicensed frequency bands.
- Mobile edge computing will bring the cloud i.e. applications, content and context closer to user locations. This will personalize the service experience through faster service delivery
- Virtualization of core and radio access network functions will optimize the use of network resources, add scalability and agility.
- SDN technologies will enable transport network resources, including fronthaul and backhaul, to become virtually programmable.
- A shared data layer will emerge to provide a single version of all network data.
- Big data analytics will support cross-layer orchestration and enable real-time action to be taken.
- Networks will become self-aware, cognitive, and implement extensive automation and continuous and predictive learning.
- Security and end-to-end management and orchestration will be embedded into the network architecture across all domains, operators will gain a programmable network architecture

5G/SDN Architecture

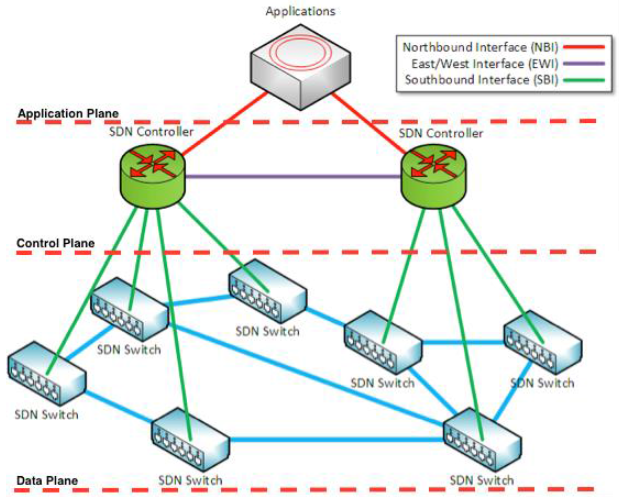


Figure 2 - Typical SDN Architecture Topology

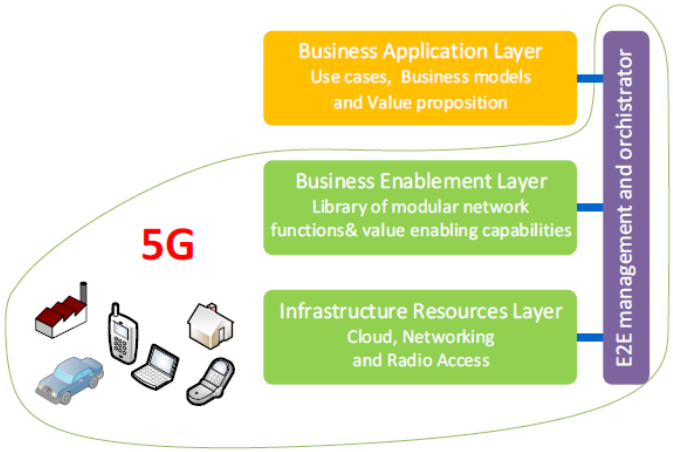


Figure 3 - 5G architecture

SDN Architecture and 5G design principles

SDN Architecture

- **The Data Plane** is responsible for the data forwarding functionality of the network and realized through a set of physical network devices (network elements).
- **The Control Plane** is responsible for the control functionality of the network. Realized through a set of controllers and devices that facilitate the creation and destruction of network flows and paths.
- **The Application Plane** is responsible for generic network management auditing, and reporting functionalities (e.g., SDN management, monitoring and security). Realized through different network management applications (e.g. Network visualization).
- **The East/West bound API** is implemented by the different controllers of the SDN and is used to facilitate communications between them.
- **The Southbound API** is implemented by the different forwarding devices in the SDN to enable the communication between these devices and the controllers of the net-work.
- **The Northbound API** is implemented by the controllers of the SDN and is used to facilitate the communication between controllers and the network management apps

5G design principles

- **The infrastructure resource layer** contains any physical device including mobile devices, Internet of Things (IoT) devices etc. (5G devices), as well as fixed networking devices (networking nodes, cloud nodes, access nodes etc.). It utilizes the SDN/NFV programmability as well as the configurability of 5G devices in order to meet the 5G design specifications (e.g. bandwidth, capacity latency).
- **The business enablement layer** contains all the necessary functions for the 5G converged network in the form of modular architecture building blocks. These blocks, along with configuration parameters, can be evoked from a common repository upon request depending on the use case.
- **The End-2-End (E2E) management and orchestration** entity has access to manage and orchestrate (or coordinate) the above mentioned architectural blocks. In addition, it defines network slices for each use case, interconnects the relevant functions of the network, assigns the proper configuration to meet E2E specifications and maps all these to the network entities of the infrastructure resource layer.
- **The business application layer** contains applications and service of the 5G network operators or other enterprises that use the network. An interface to the E2E management and orchestration entity can be used to map an application to existing network slices, or to create new slices for the applications.

Activities SDN/5G TTL

- Classification of assets: Mostly for SDN
- Classification of threats: Following ETL taxonomy!
  - SDN
  - Network Virtualization
  - 5G Threats
- Threat Agents classification
- Good practices:
  - Existing mitigation practices
  - Threat mitigation practices under development
- GAP analysis
- Recommendations
  - Technical recommendations
  - Organizational recommendations

SDN/5G Assets

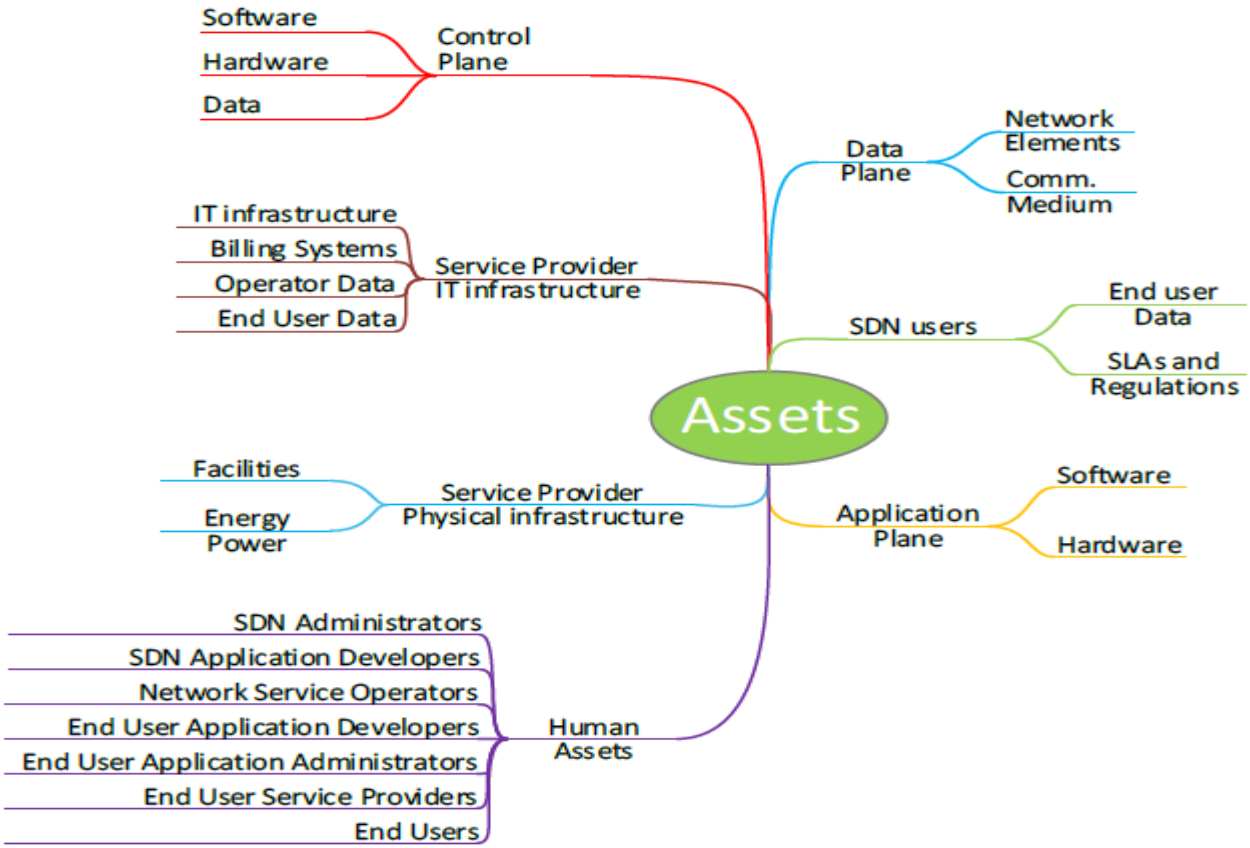
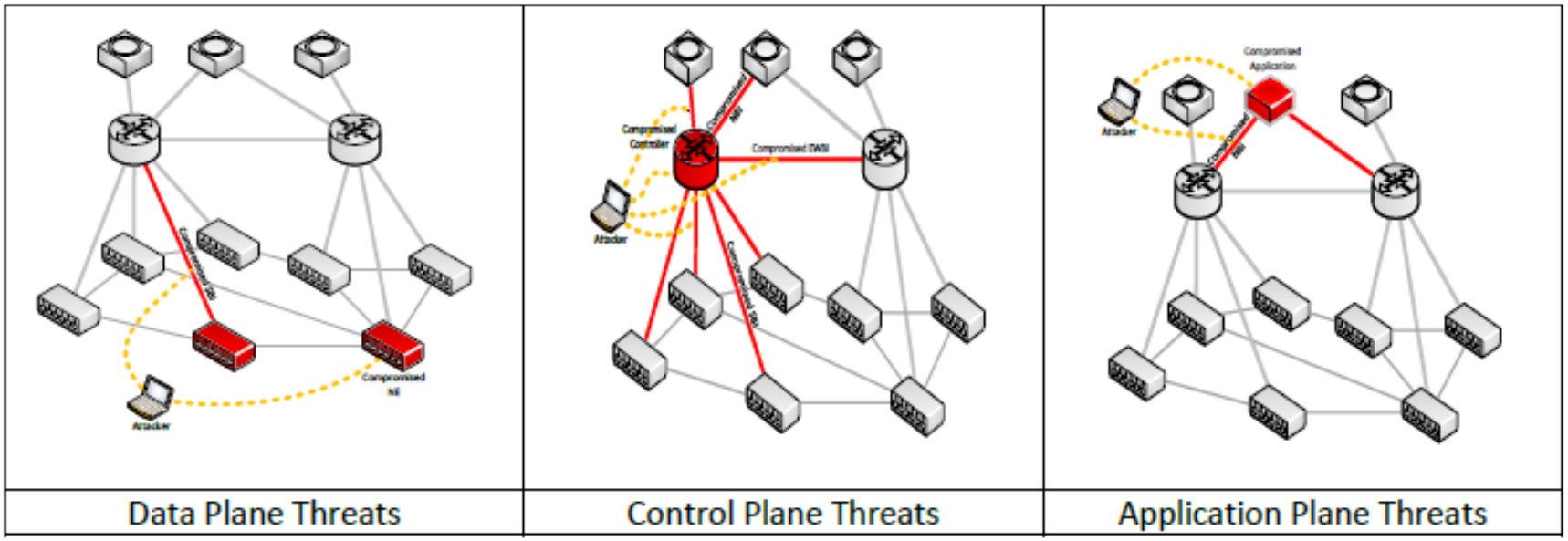


Figure 4 - SDN assets threat landscape

SDN/5G Threats

- SDN “specific” threats
- Network Virtualization threats
- 5G/Radio access threats

SDN threats



Data Plane Threats	Control Plane Threats	Application Plane Threats

Figure 5 - Threats of SDN reference architecture

SDN Threats

API exploitation: This threat involves exploiting the API of a software component in order to launch different types of further attacks. API exploitation may relate to all the different types of APIs that may be found in an SDN. These include:

- Northbound API (Northbound API exploitation) that facilitates the communication between SDN controllers and SDN applications;
- Southbound API that facilitates the communication between SDN network elements and SDN controllers
- Eastbound/Westbound API that facilitates the communication between SDN controllers

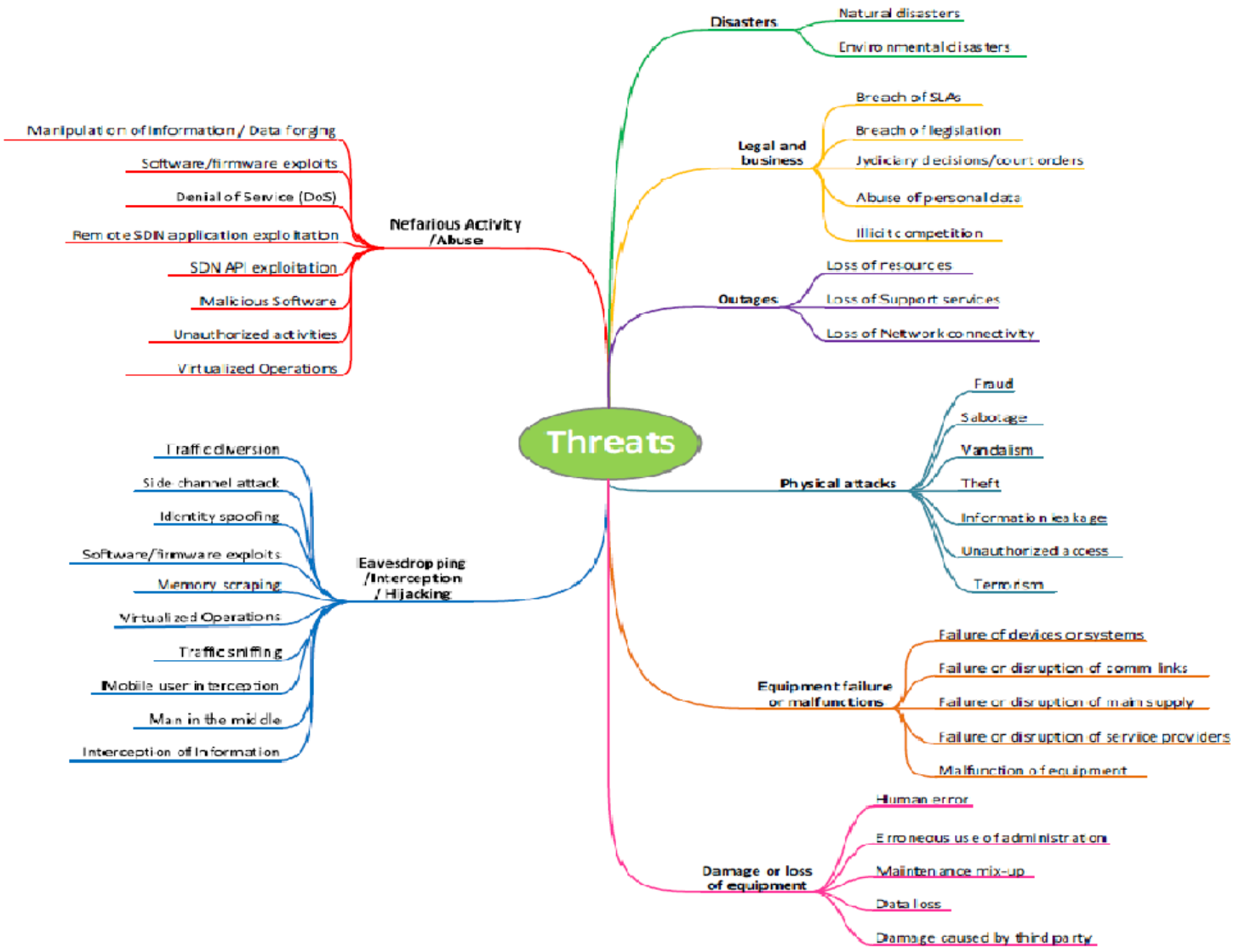
Memory scraping: This threat arises when an attacker scans the physical memory of a software component in order to extract sensitive information that is it not authorized to have. Memory scrapping can affect components of any layer, this type of threat has been primarily identified for application servers.

Side channel attack: This threat involves extracting information on existing flow rules that are used by net-work elements. The threat can be realized by exploiting patterns of network operations (e.g. exploiting the time required for establishing a network connection). Side channel attacks is a threat relating to network elements of the data plane.

Data forging: This threat involves compromising an SDN element (e.g., controller, router, switch) in order to forge network data and launch other attacks (e.g., DOS). Data forging is a threat related to components in the data plane and the controller plane

Software/firmware exploits: Involves exploiting vulnerabilities of the software/firmware, in order to cause some malfunction, reduction or disruption of service, eavesdropping of data or destruction/compromising of data. Software/ firmware exploits may occur in all layers of the SDN reference architecture.

Taxonomy of SDN Threats



Network Virtualization Threats

Threats related to servers running virtualized network functions (virtualized host abuse). Virtualization of functions and their operation on virtual machines (e.g., a server that can be used as a network switch) is a common practice in SDN. Therefore traditional security threats for servers running virtualized network operations such as network monitoring, access control, network management etc. should be considered.

Threats to data centers hosting SDN operations (Data center threats). Many SDN systems are deployed within data centers. Hence, security threats of data centers should be considered, similarly to the server case. Moreover, data servers are using Data Centre Interconnect (DCI) protocols, which may lack authentication and encryption to secure the packet contents. Thus an attacker could create spoofed traffic in such a way that it traverses the DCI links or to create a DoS attack of the DCI connections.

Threats related to virtualization mechanism: (Network Virtualization bypassing). The use of the network between different tenants need to assure that only legitimated traffic enters or leaves a network slice, but also that any switching element checks and enforces the traffic isolation by installing legitimate flow-rules preventing slice trespassing.

5G Radio Access Threats

User emulation: Adversaries can exploit the wireless medium by mimicking the incumbent signals. Such at-tacks can be launched by:

- Greedy mobile nodes, mislead other users by transmitting fake incumbent signals in order to lead them to leave a specific band and gain exclusive use of it
- Malicious mobile nodes that to cause Denial of Service (DoS) attacks by mimicking incumbent signals

Spectrum sensing data falsification. The received signal power may enforced to become lower compared to what path loss models have predicted due to transmission features such as signal fading or multipath propagation. This may lead to harmful interference due to undetected primary signals.

MAC layer attack. This category of attacks includes:

- MAC spoofing in which attackers send spurious messages that disrupt the network operation
- Congestion attacks in which attackers flood Common Control Channel in order to cause an extended DoS attack
- Jamming in which adversaries trigger DoS attacks by creating interference at the physical layer.

Recommendations

Technical Recommendations

- Recommendation 1 (for Network providers): Mandate encryption and authentication in NBI, SBI and EWBI.
- Recommendation 2 (for Network providers): Identify and monitor exposed functionalities of SDN controllers.
- Recommendation 3 (for Network and Service providers): Control and monitor running application resources.
- Recommendation 4 (for Network, Service providers and End users): Holistic Support for Security policies.
- Recommendation 5 (for Administrators): Access control, Credentials, System updates.
- Recommendation 6 (for Developers): Sandbox-ing, Application Isolation.

Recommendations

Organizational Recommendations

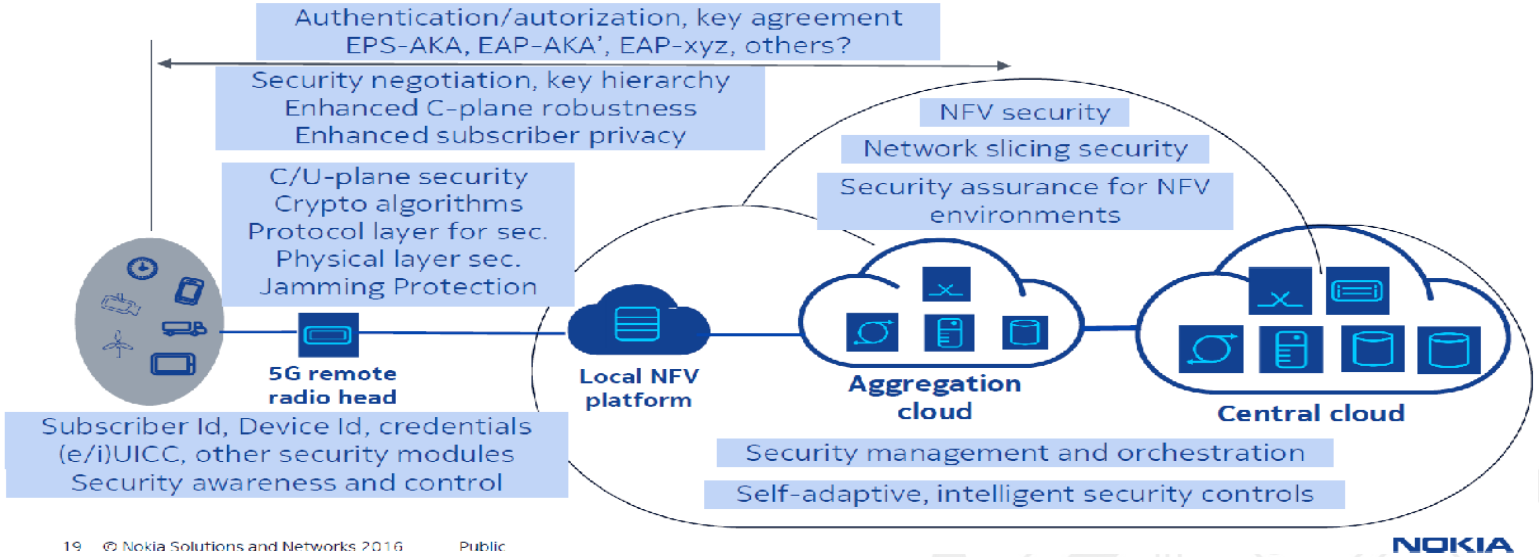
- Recommendation 7 (for Service providers): Develop incident response capabilities and in-formation sharing practices among telecom operators.
- Recommendation 8 (for Administrators): Keep systems up to date.
- Recommendation 9 (for Network and Service providers): Use adequate security methods.

Challenges on 5G security

- Standardization challenge
- Trust model and Identity Management
- 5G radio network security
- Flexible and scalable security architecture
- Energy-efficient security
- Cloud security

Conclusions

- There is a long way for 5G
- Must be prepared for old and new threats: Different and new layers implies new attack surfaces
- There is a good opportunity to implement security by design
- SDN/NFV is a key actor to improve security on 5G



How can ENISA help?

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