Evaluating future internet technologies

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SIDN Labs BYOL | Arnhem | 15 July 2019

Outline

- Aim of this BYOL…
- Scoping for today…
- IPv4/IPv6: Internet Protocol…
- Families of network technologies…
- Evaluating network technologies…
- Use cases/demonstrators…
- Brainstorm…

Aim of this BYOL

Aim of the BYOL

- Have your lunch
- Find out if we need to change the present Internet:
  - Examples, use cases, solutions, demonstrators
  - Brainstorm with you

Scoping for today

Scoping today

- Concentrate on inter-network and upto and including the network layer
  - Not looking at: software vulnerabilities of end hosts or malicious Internet content
- Multi-domain, governance, trust and deployment aspects are important from the start
- Focus on realistic/practical use cases and demonstrators
- Evaluate existing technologies using open source code and active communities with testbeds. Supported by IETF/IRTF and/or other standard/recommendation bodies
- Hands-on using an experiential approach: interconnected 2STiC testbed
- Key words: Security, stability and transparency…

Faithful transparency

- User:
  - to provide a sense what the system is doing and why
  - to understand why one particular prediction or decision was reached
  - to feel comfortable with a prediction or decision so that they keep using the system
  - to lead into some action or behaviour
- Provider (network or service):
  - to understand how their system is working, aiming to debug or improve it
  - to facilitate monitoring and testing for safety standards
- Society:
  - to understand and become comfortable with the strengths and limitations of the system
  - to audit a prediction or decision trail, particularly if something goes wrong

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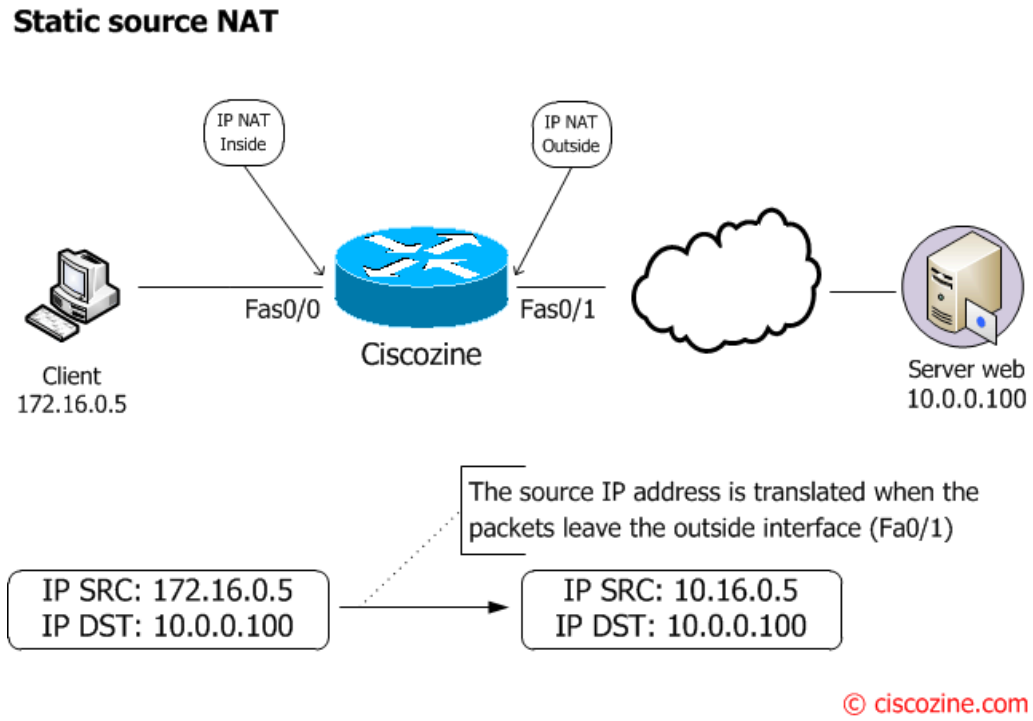
IPv4/IPv6: Internet Protocol

IPV4/IPv6: Internet Protocol

- Established
- Using feature set of IPv4/IPv6 as a reference/base-line



Source: https://www.ciscozine.com/nat-and-pat-a-complete-explanation/

Lessons learnt from 40 years of networking

- Multipoint (“dissemination”) services are needed beside unicast services (“conversations”)
- Mobility (movement between networks) has shown to be pivotal
- Support for quality guarantees (e.g. latency guarantees for autonomous vehicles) is becoming important

- Some applications need path control and verification (e.g. evading certain jurisdictions)
- Self-determination/transparency on the use of user-data (ads, profiling, steering) is needed
- Security awareness has grown enormously and thus security service are needed (against e.g. DDoS, BGP hijacks)
- Local incidents should not have global effects (e.g. a CA compromise, BGP hijacks)

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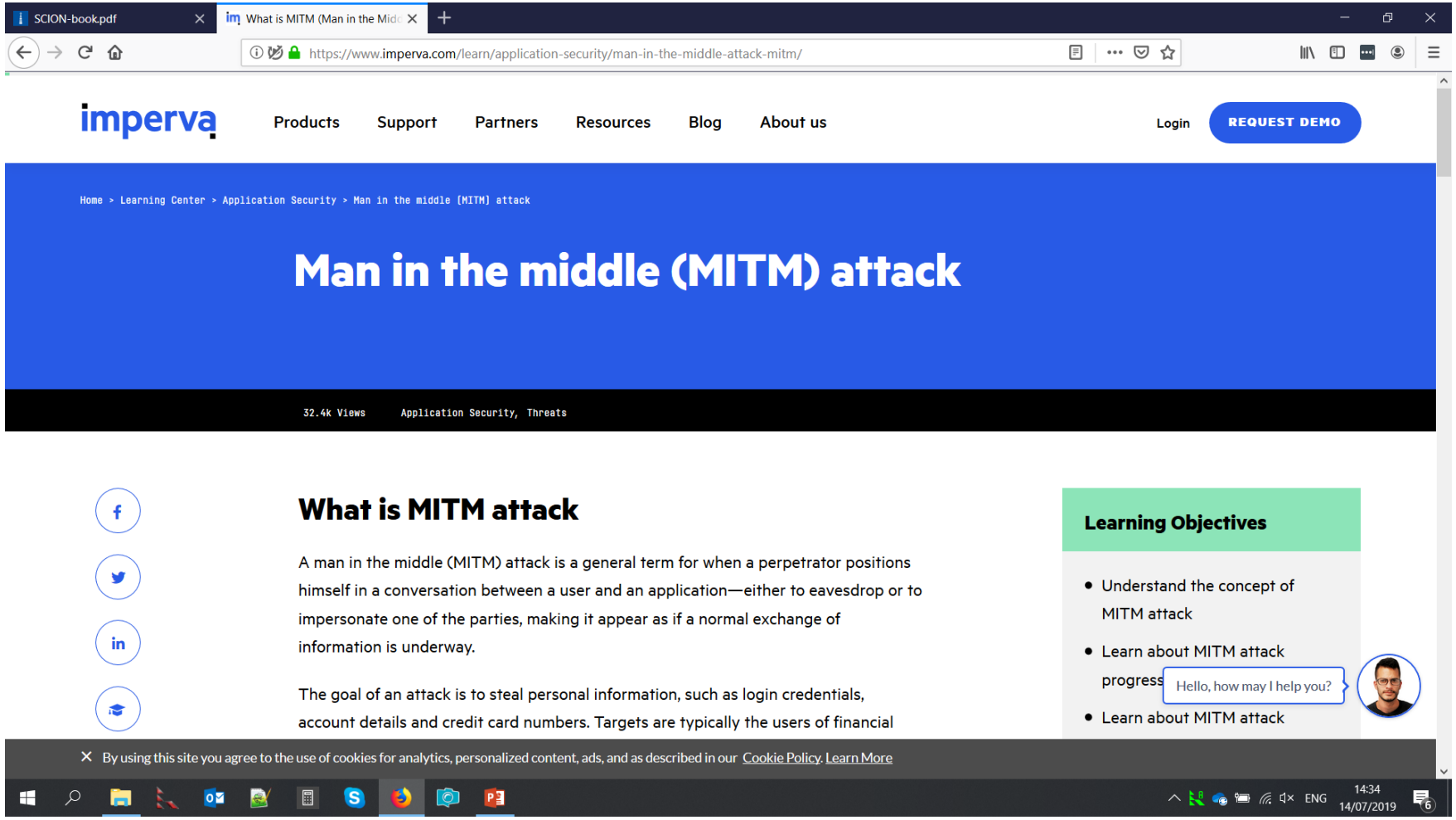
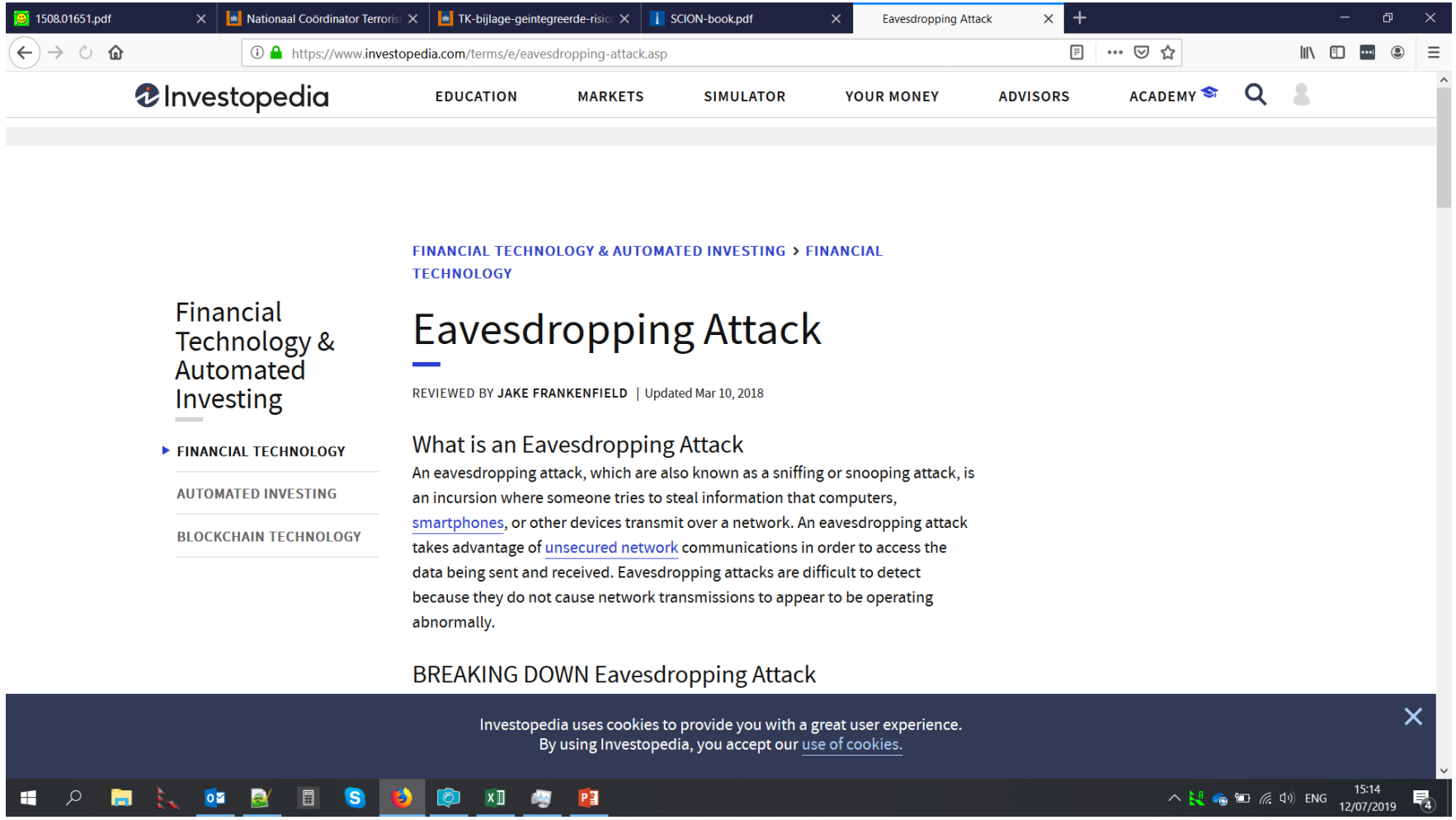
Some threads

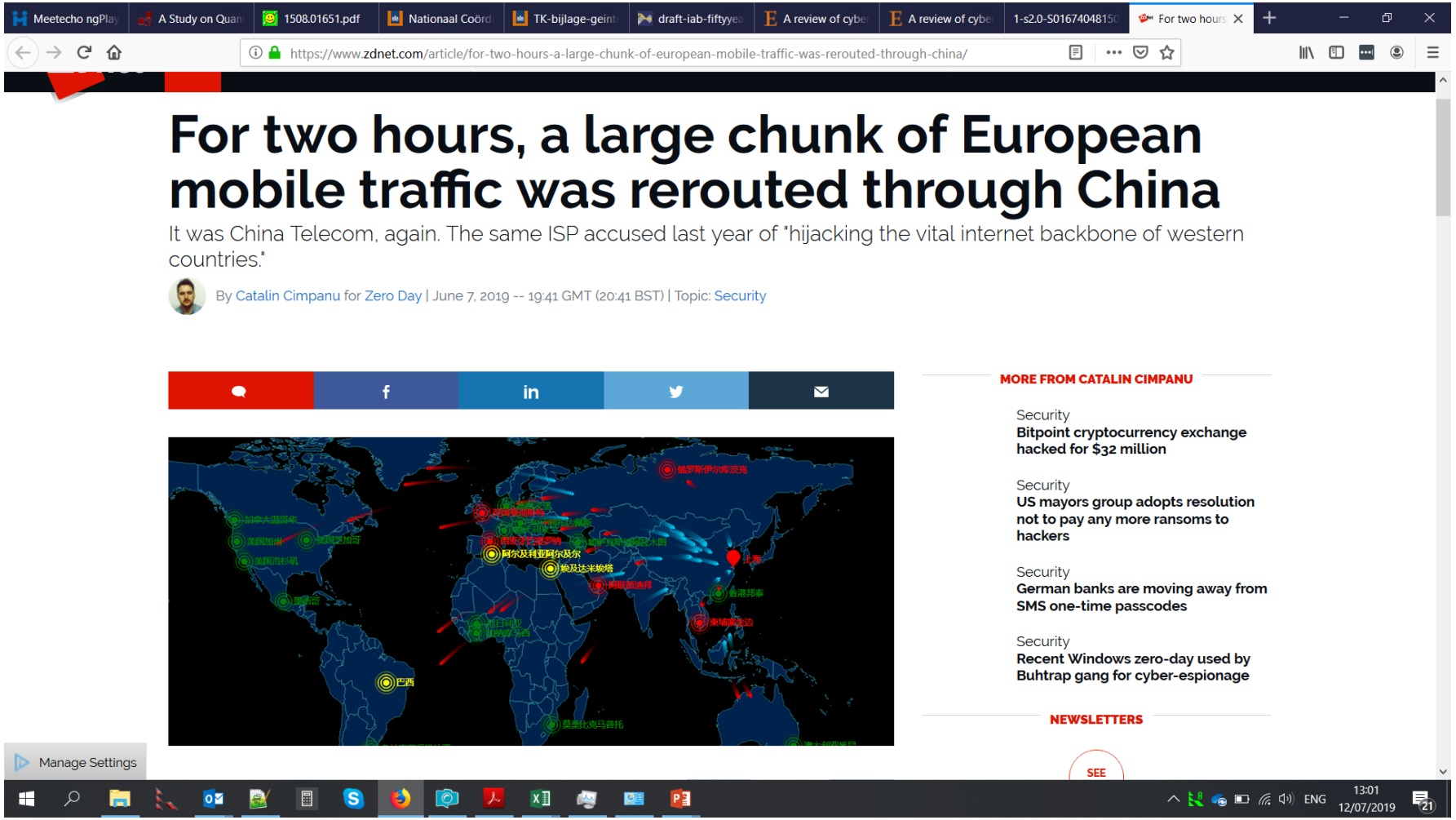
Man in the middle



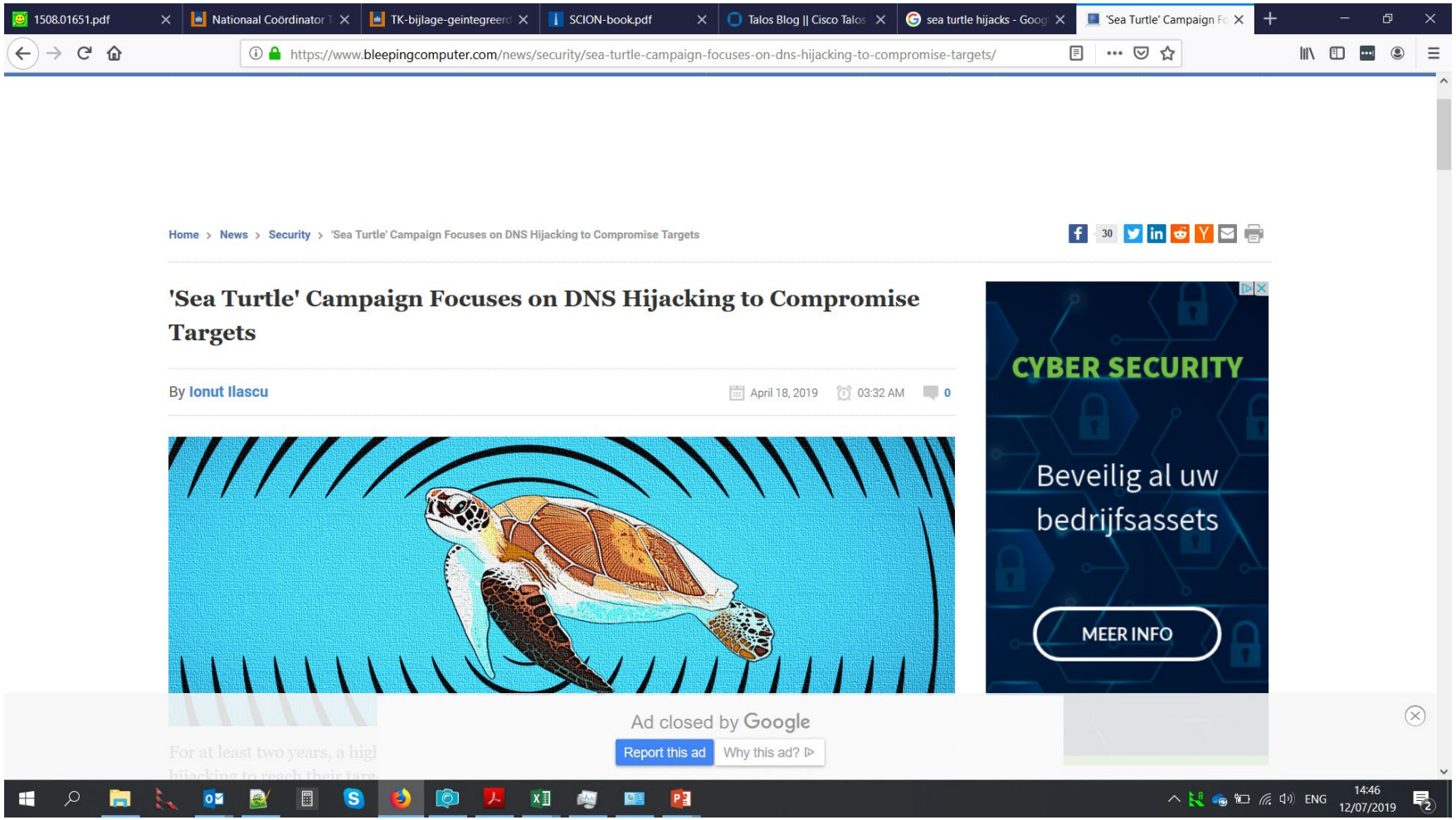
Eavesdropping



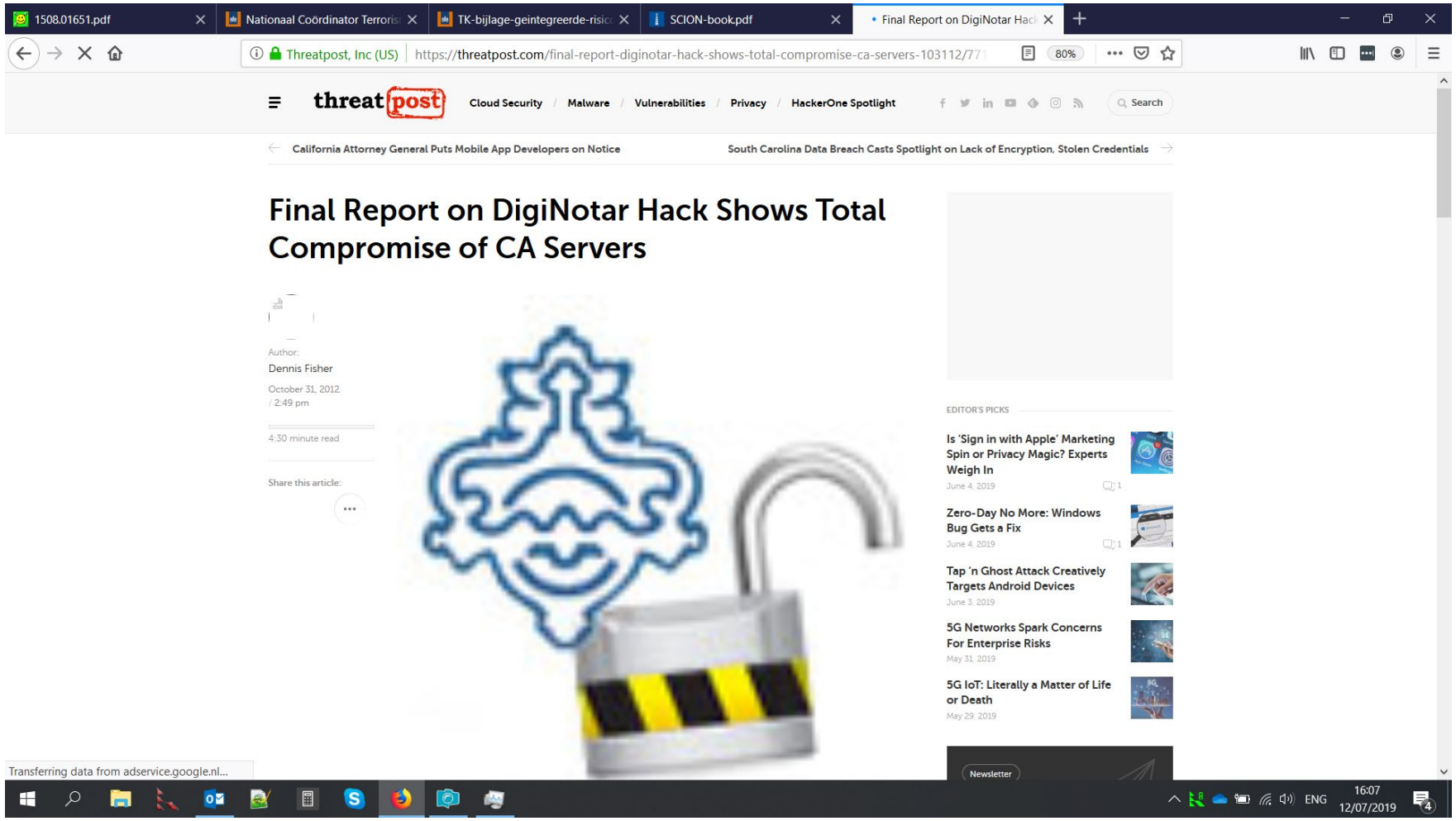
Prefix hijack



DNS hijacking



Forged TLS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SCION-book.pdf
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Threatpost, Inc (US)
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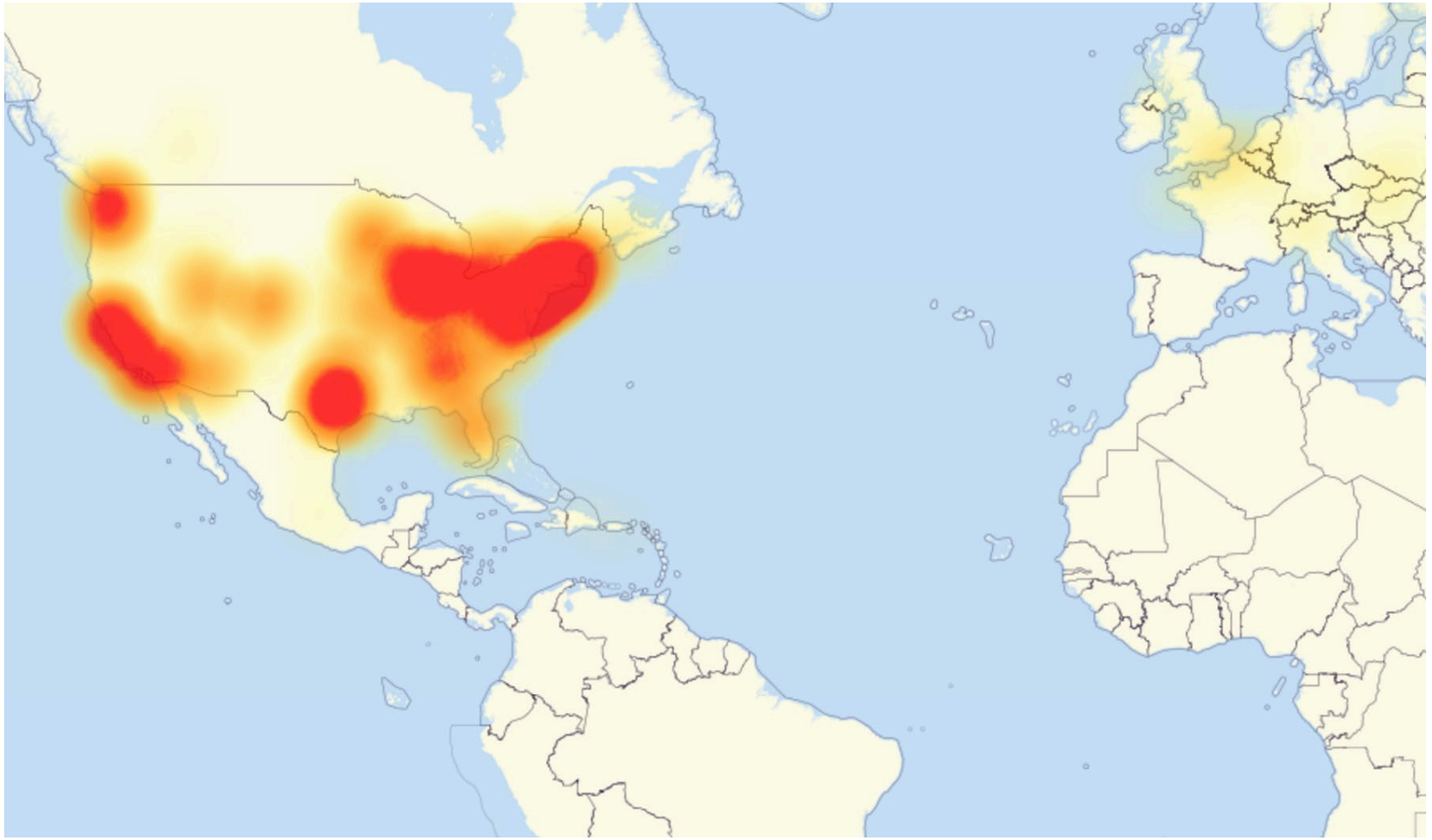
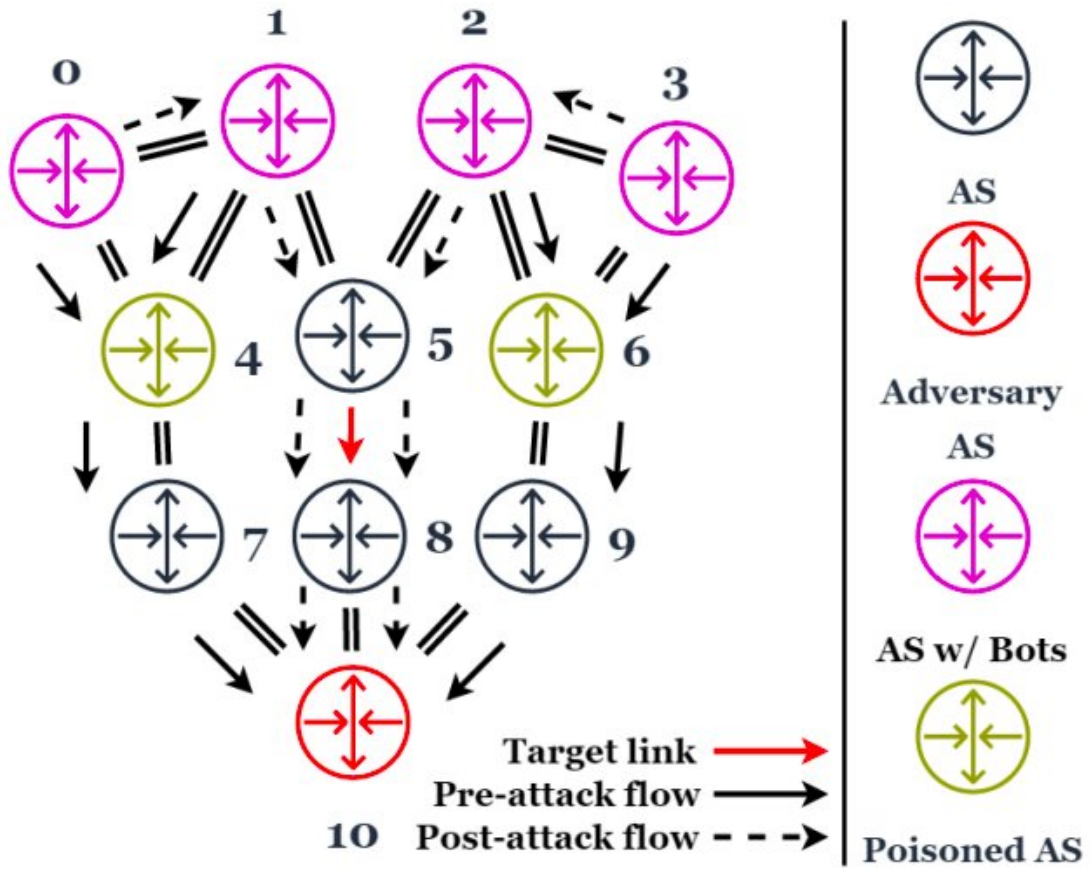
DDoS/Botnet attack: Dyn DNS using IOT devices

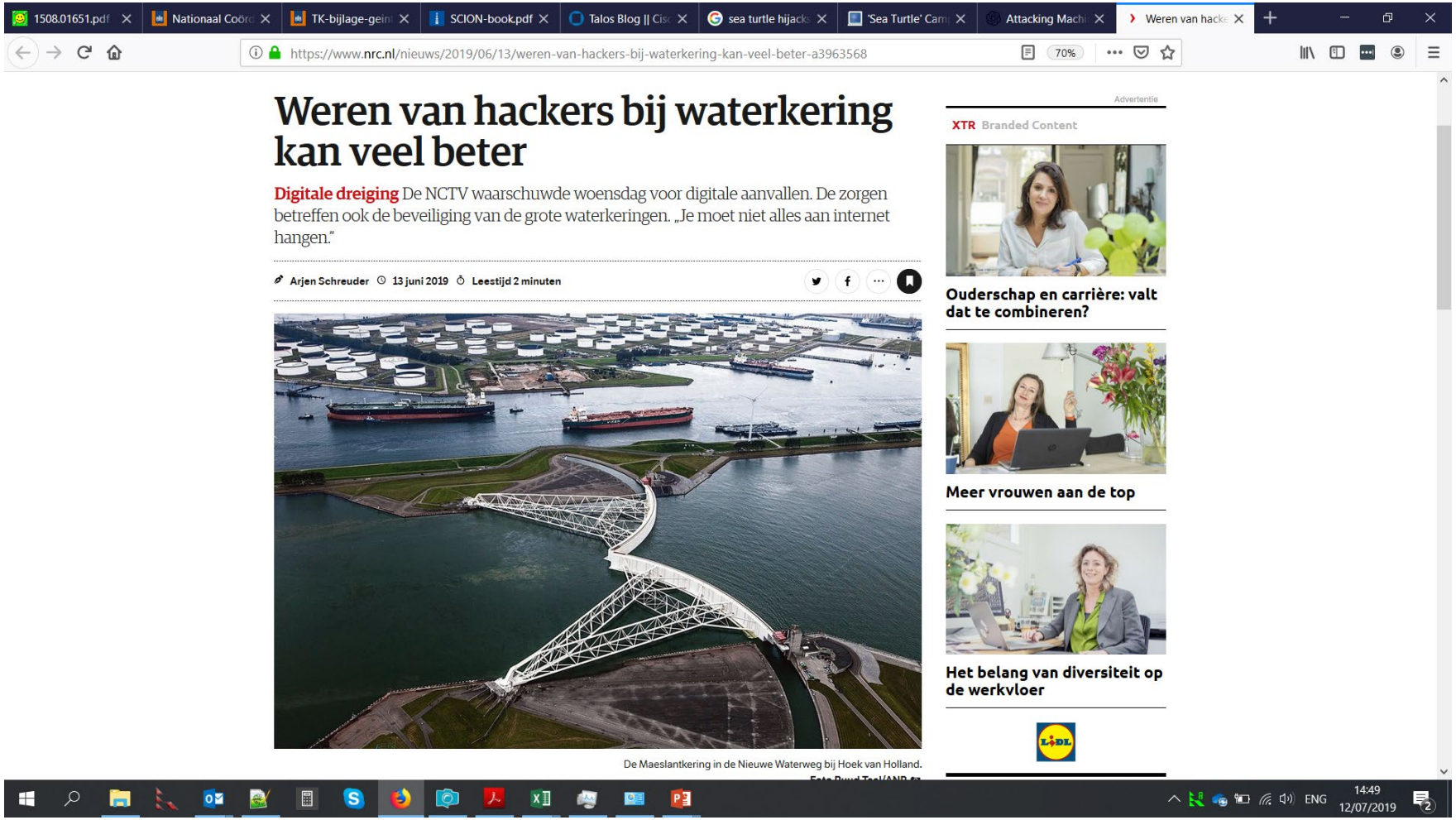


Source: https://en.wikinews.org/wiki/Distributed_malware_attacks_Dyn_DNS,_takes_down_websites_in_US

Compromised AS': Maestro attack

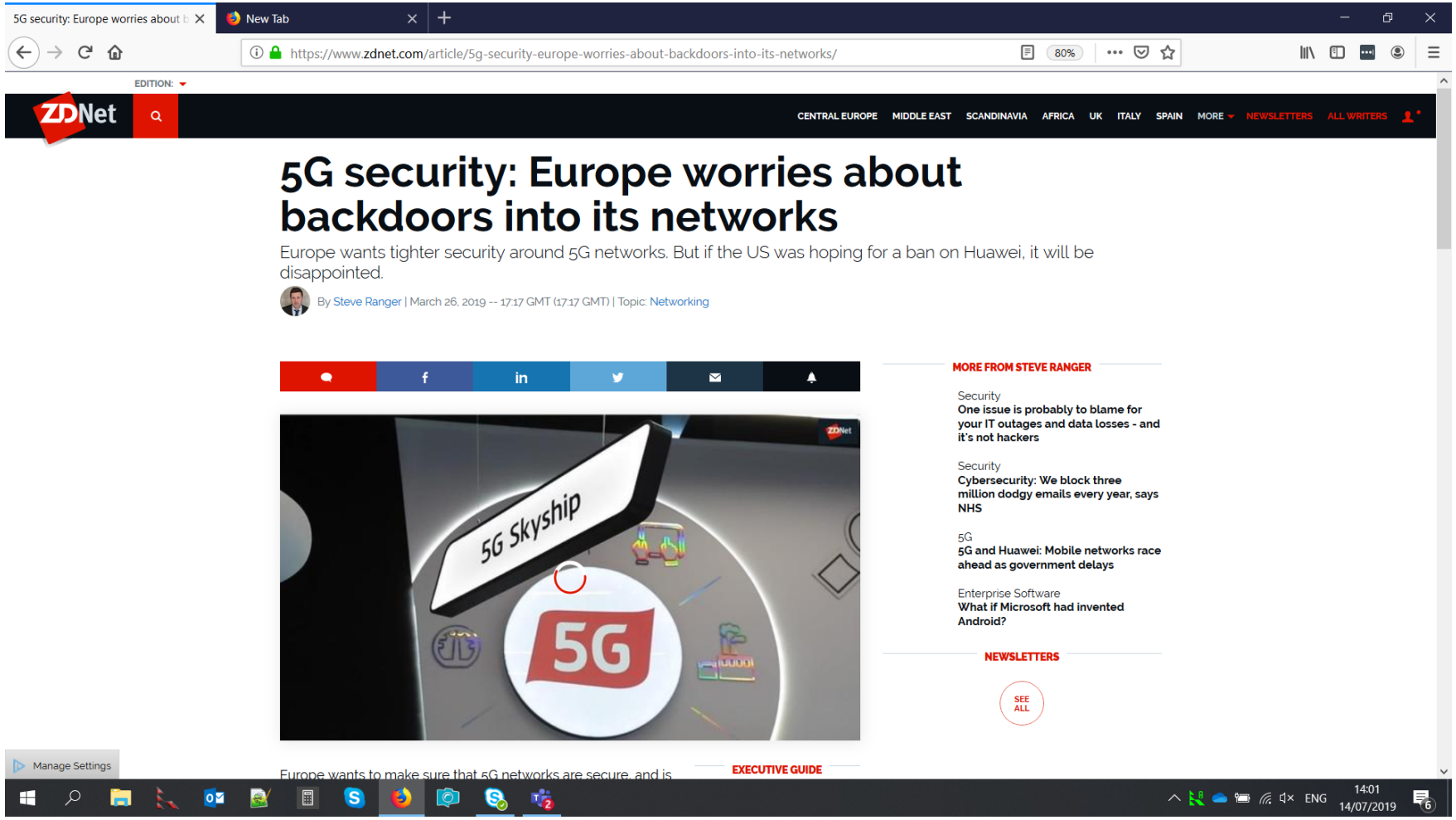


Control network security (SCADA/ICS/IOT)

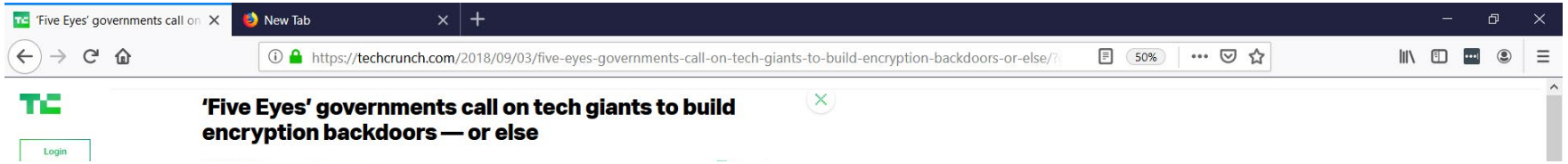


IP/MAC address spoofing

Backdoors: governments worry about backdoors



Backdoors: governments demand backdoors



8983/19

LIMITE

CT 45
COSI 97
CATS 67
ENFOPOL 213
TELECOM 202
CYBER 144

NOTE

From:	EU Counter-Terrorism Coordinator
To:	Delegations
Subject:	**Law enforcement and judicial aspects related to 5G**

https://www.nporadio1.nl/reporter-radio/onderwerpen/507473-het-5g-netwerk-onder-de-loep

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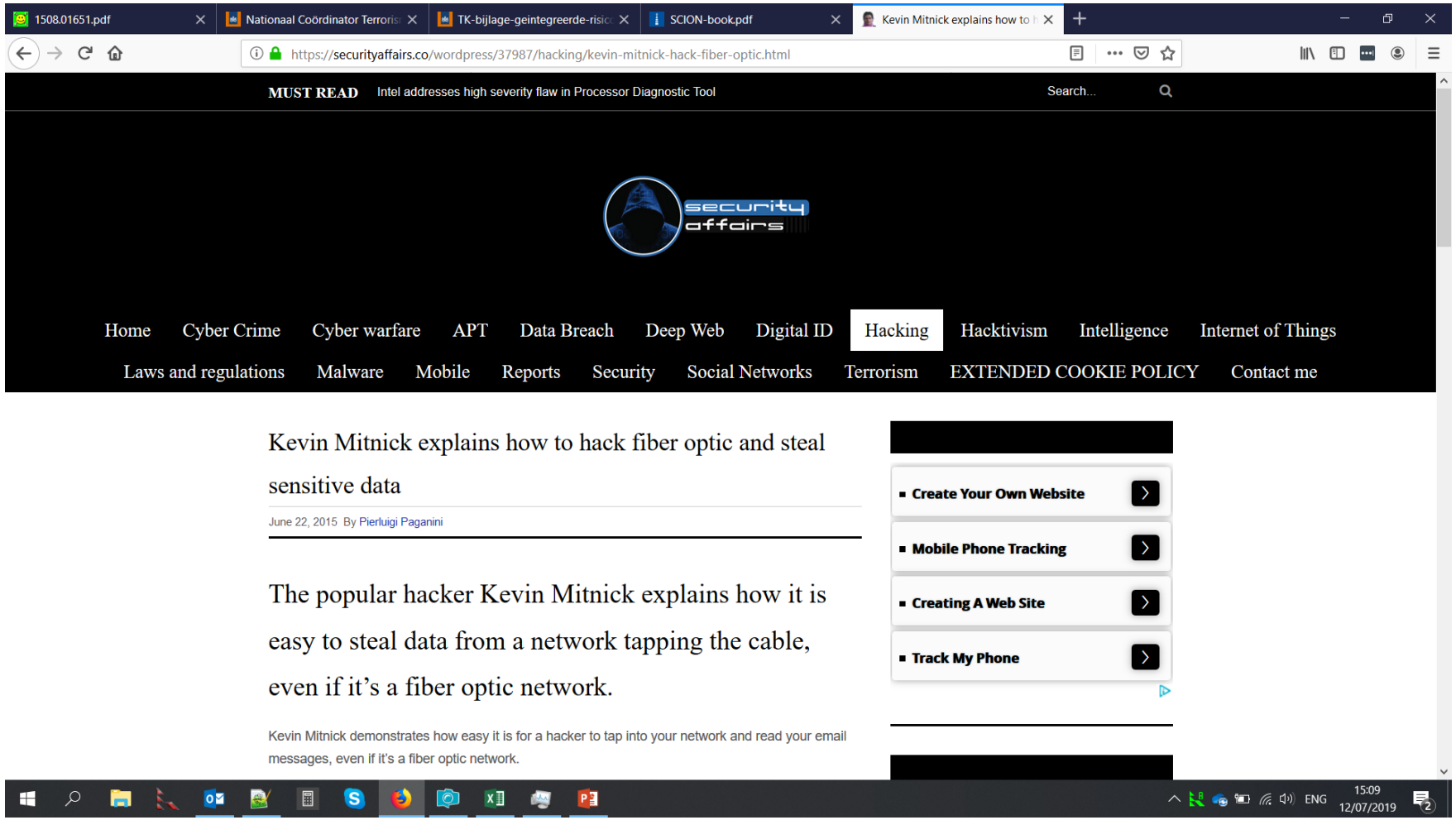
Physical access



Families of network technologies

How clean is clean slate?

- Can the new technology be introduced in a phased way (dual stack or in the core network and still have the existing technology in access network)
- How does it integrate with the established technology (in this case IPv4/IPv6)?
- Is one prepared (in the long term) to change/remove the established technology?
- Do application's APIs need to be changed?
- How developed (TRL levels) are implementations of the new technologies?

internet technology families

- Packet/bit based
  - Established (IPv4, IPv6)
  - Link/physical layer
    - Intermittent and high latency connectivity
    - Mobility
    - Fundamentally different communication physics
  - Programmability
    - PHB networking
    - Network virtualisation
    - Shaping industry structure
    - Services in the network
  - New network design principles
    - Minimum need for global unique identifiers
    - Regionality
    - Architecture for change (SCION)
    - Conceptual clarity (RINA)
- Information based
  - Performance increase due to objects
  - Information centric networking (NDN)

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Evaluating network technologies

Evaluation guidelines (1/2)

- Needs of society
  Support society development, secure, utility, trust, ecology, privacy
- Generality
  Unknown future, look at all layers, modularity
- Longevity
  Evolvable, adaptable, flexibility, solving a (imminent) problem, transition planning, KISS
- Services
  Type of services, design, expressive power, control by end nodes, transparency

Evaluation guidelines (2/2)

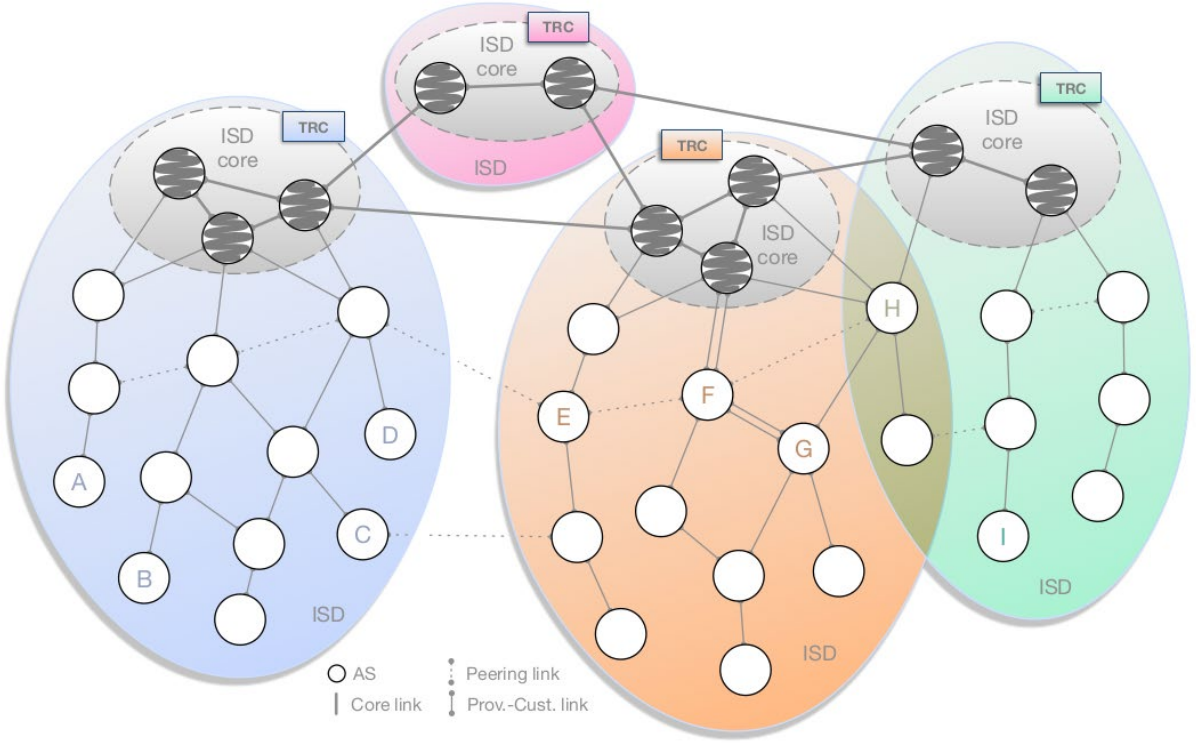
- Naming and/or addressing
- Control and management: FCAPS
  Fault, Capacity, Accounting, Performance (Stability) and Security
- Economical viability
  Deployable, fitness for purpose, involved stakeholders, vendors.
  TCO
- Solving threads
- Supporting our demonstrators

Technologies planned to be evaluated

- SCION: Stability, Control and Isolation on Next-generation networking…
- RINA: Recursive InterNetwork Architecture…
- NDN: Named Data Networking…

SCION: Stability, Control and Isolation on Next-generation networking

- Architecture for change
- In first instance about one-to-one communication



Source: The SCION Internet Architecture: An Internet Architecture for the 21st Century, Barrera et al., 2017

SCION principles

- Scalability
  - packet-carried forwarding state
  - hierarchical design
- Control
  - ISPs decide available paths
  - endhost selects path

Transparency

- Isolation
  - isolation domains (failure stay with one)
  - built-in DDoS protection

Security

- On Next-generation networks
  - new control plane & data plane (replaces IP + BGP)
  - endhost-controlled multipath for free

Stability

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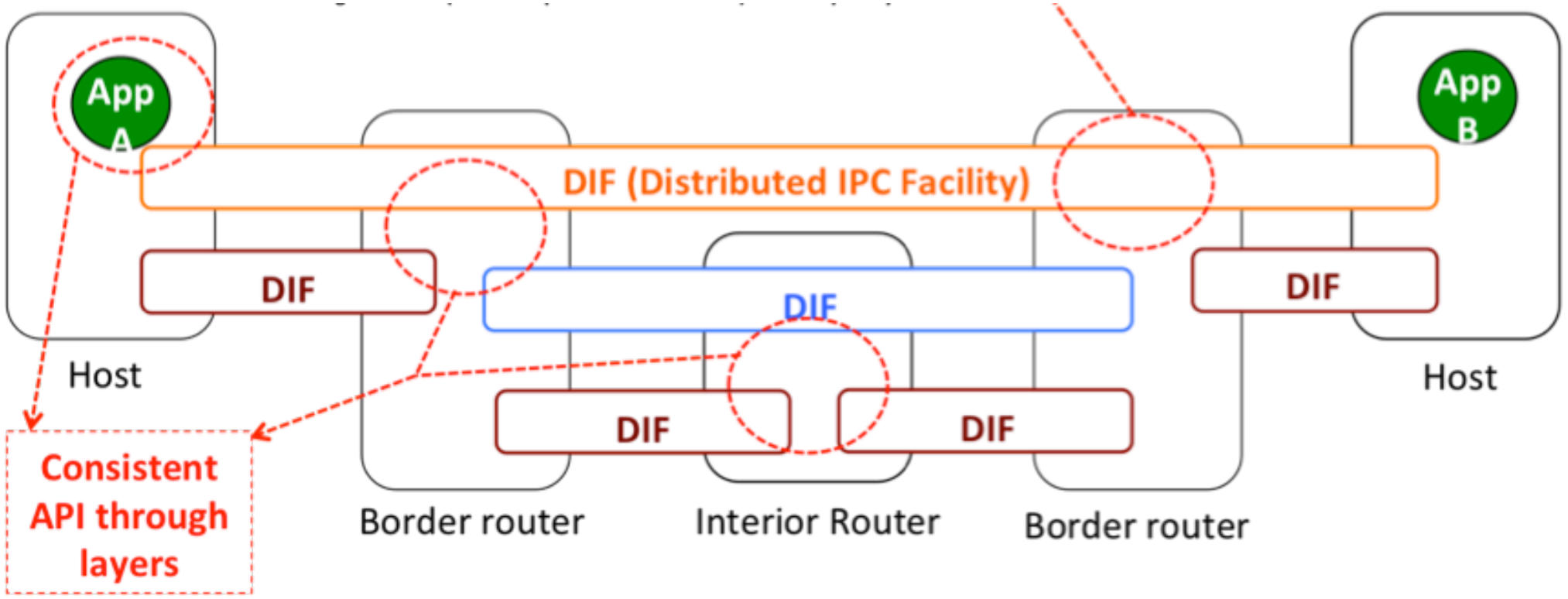
RINA: Recursive InterNetwork Architecture

- Framework for conceptual clarity
- SCION can be a RINA DIF



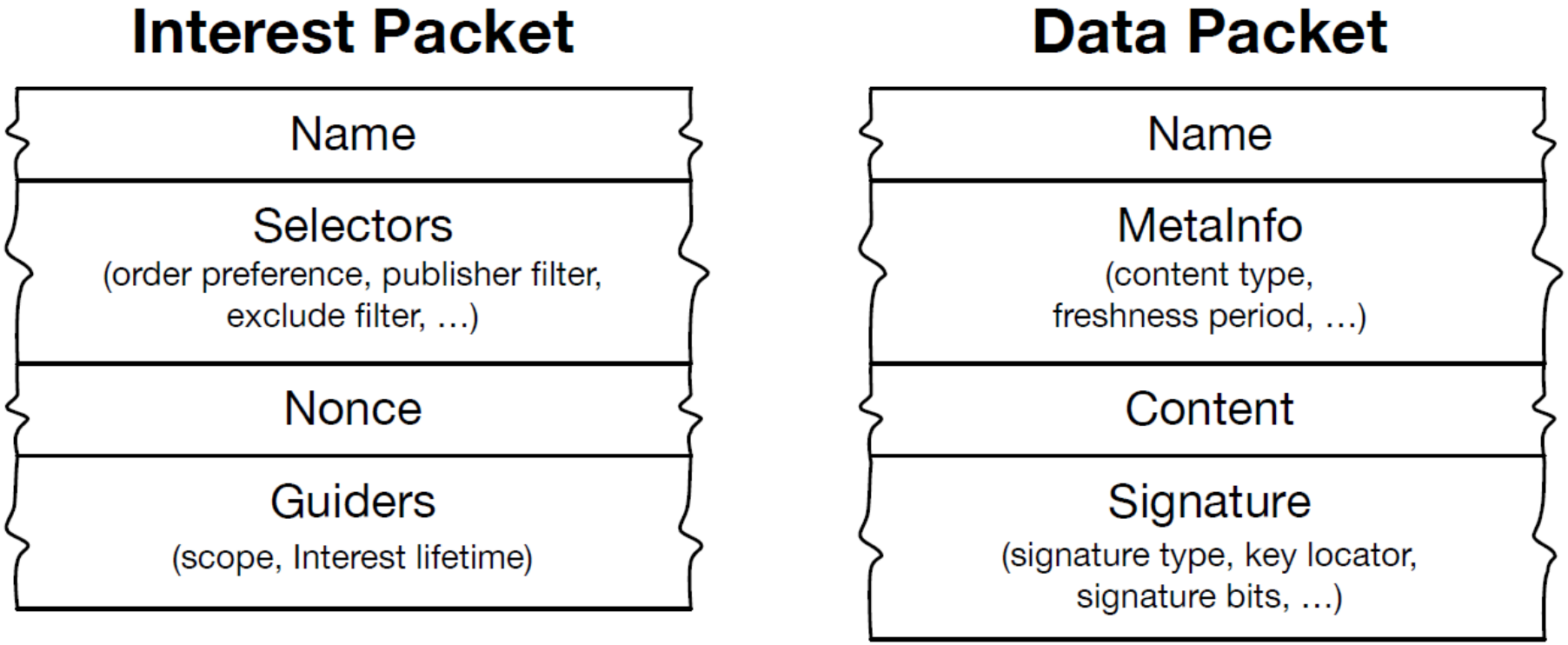
Source: http://ict-arcfire.eu/index.php/rina/

RINA framework principles

- Structure
- Protocol design
- Naming, addressing and routing
- Mobility and multi-homing
- Quality of Service, resource allocation, congestion control
- Security
- Network Management
- Path-aware networking
- New routing + forwarding architecture
- Provable security: Protocol + Code
- Heterogeneous trust model
- Built-in DDoS defence mechanisms

NDN: Named Data Networking

- Information centric networking
- One to one communication is somewhat problematic



Source: By NDN Consortium - named-data.net, CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=35288191

NDN principles

- Evolvement from existing host-centric to data-centric
- Authentic: a valid/cryptographic name-to-content binding
- Trustworthy: reputable or trusted origin
- Not specifically a Delay/Disruption-Tolerant Network

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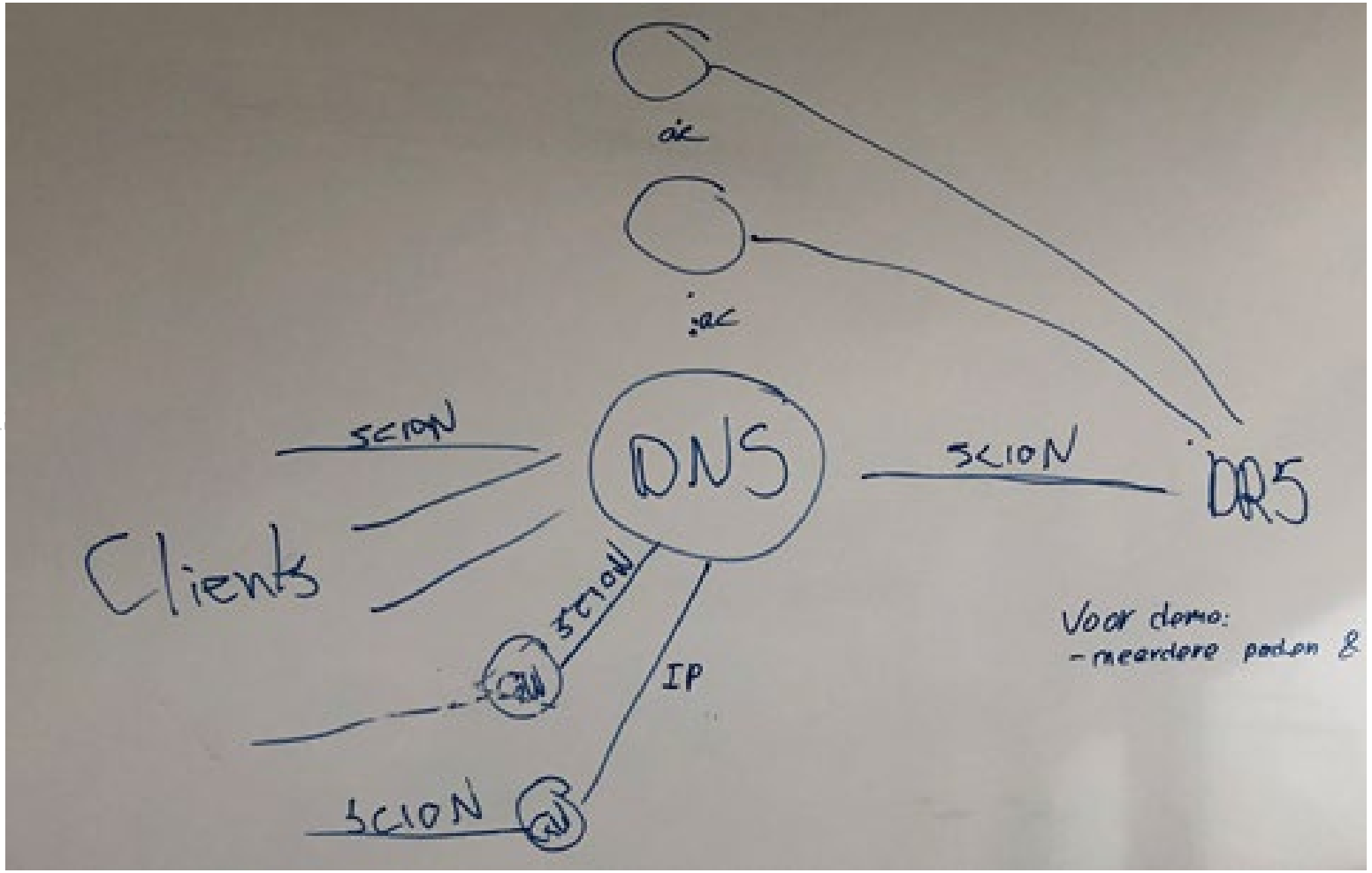
Use cases/demonstrators

Use cases/demonstrators

- Existing IP services
  - DNS (2019 KPI)
  - AMS-IX
- IOT/ICS related
  - Intelligent Transport System
  - SCADA/ICS
  - Rijkswaterstaat
  - Smart girds
- Transactions
  - Banks
  - Customs



Use cases/demonstrators

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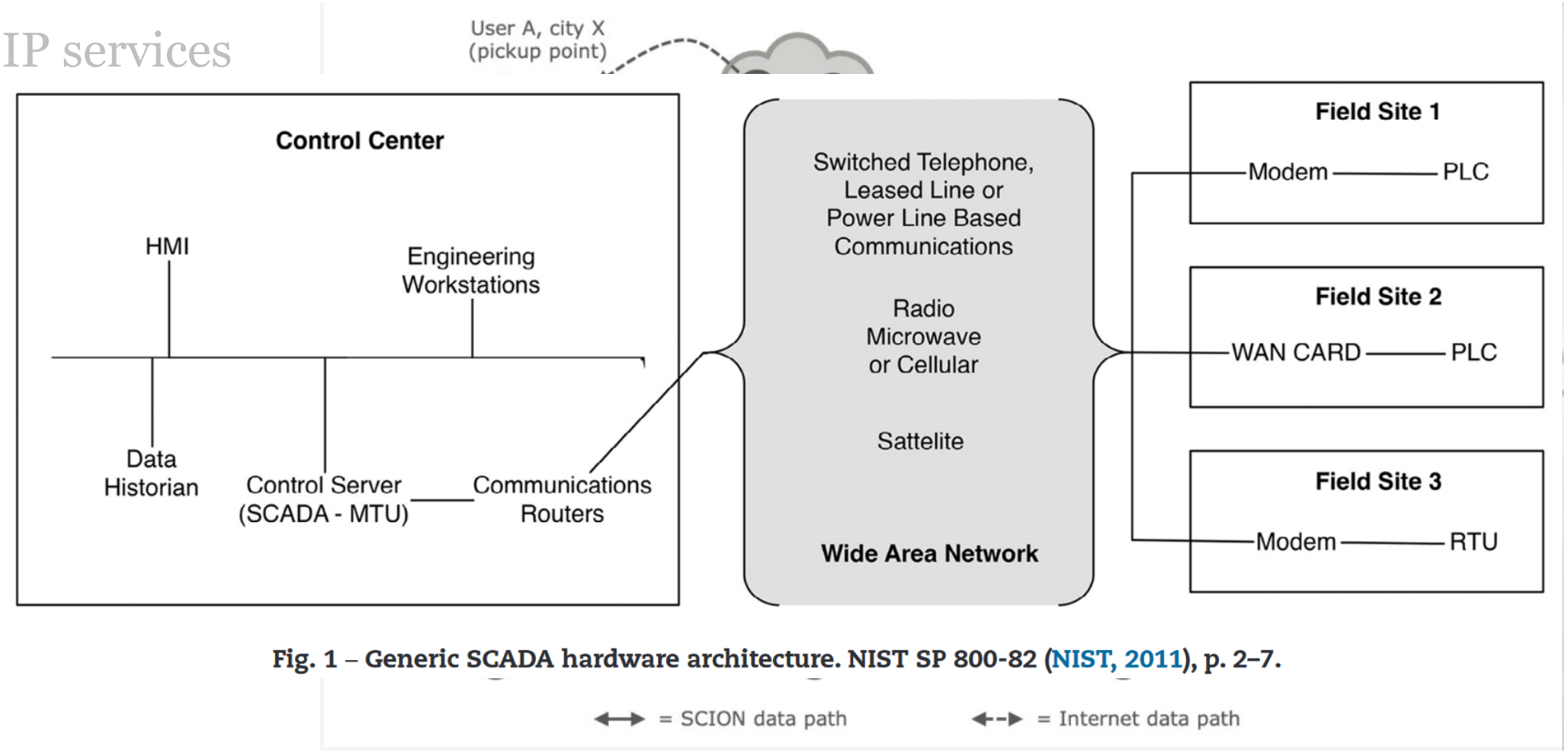

Fig. 1 – Generic SCADA hardware architecture. NIST SP 800-82 (NIST, 2011), p. 2–7.

Use cases/demonstrators

- Existing IP services
  - DNS (2019 KPI)
  - AMS-IX
- IOT/ICS related
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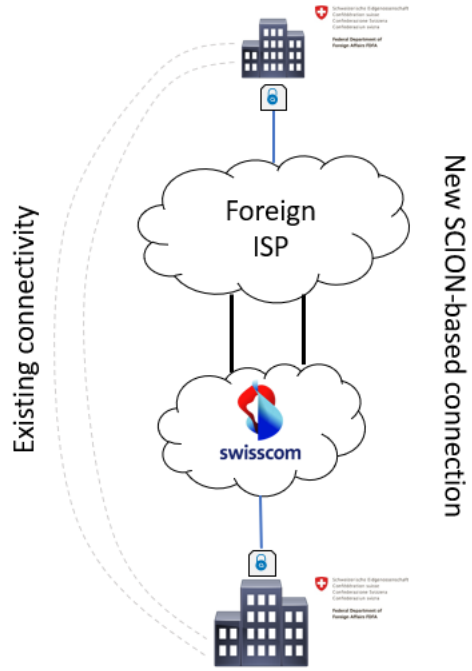
  - Smart girds
- Transactions (betalings v
  - Banks
  - Customs

Use Case 2: Connecting Swiss Embassies to Bern

- **The Challenge:**
  - Secure and alternative connection between one of the most important Embassies and its headquarters
- **The solution:**
  - SCION Connection via 2 Service Providers as managed service
- **The results:**
  - Latency improved over existing connectivity
  - Interdomain-Failover tests successful
  - SCION connection replaced existing connections as default path



anapaya systems

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Brainstorm

Brainstorm

- Do you have other threads?
- Do you know other future network technologies?
- How should we evaluate future network technologies?
  - Availability of STOP function, society need (China, Europe, USA, company, et.)
- Do you have other examples of use cases?
  - Filesharing, videostreaming
  - Understand demands of user groups.
- What is the preference: add functionality to IP or introduce a future network technology?
- Should this future network technology replace IP?
- What if we broaden this to the whole stack?
  - Providers: network providers and service providers

Volg ons

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Thanks for your attention!

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