What do incident response practitioners need to know? A skillmap for the years ahead

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What do incident response practitioners need to know? A skillmap for the years ahead

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Call for Experts

- Growing need for Digital Forensics and Incident Response (DFIR) professionals
  - Law enforcement
  - Private sector
- Big jump in cybersecurity job postings
  - 74% from 2007 to 2013, double the rate of all other IT jobs[1]
  - 97% from 2013 to 2019, 13% of all IT jobs[2]
- Shortage of trained specialists worldwide

[1] (Vincze, 2016)

[2] (Zan & di Franco, 2020)

Official Statements

USA: "82% of employers report a shortage of cybersecurity skills, and 71% believe this talent gap causes direct and measurable damage to their organizations." (J. A. Lewis, US CSIS 2019)

UK: "The challenge is much more complex than simply a shortage of cybersecurity professionals – there is a broader cybersecurity capability gap in the UK." (HM Government, 2018)

France: "The content and number of initial training and higher education programmes for cybersecurity professions do not meet the needs of businesses and administrations." (Premier Ministre, 2015)

Germany: "The shortage of IT security specialists no longer affects only the economy, but also increasingly the public sector." (Schuetze, 2018)

Italy: "Italy has a vast problem in relation to cybersecurity education." (Presidenza del Consiglio dei Ministri, 2018)

Issues

"Training is a serious problem facing oraganizations that deliver forensic services. As a result, many organizations report that it typically takes between one and two years of on-the-job training before a newly minted forensics examiner is profficient enough to lead an investigation." (Garfinkel, 2000)

- Several studies[1] identified a major issue in the lack of:
  - Adequate skills & training
  - Certifications, standards and guidelines
- Others[2] revealed:
  - Limited offering of cybersecurity courses in computer science curricula
  - Poor alignment between education offering and labor market demands
  - Mostly theory-based, insufficient focus on practical excersises

[1] (Henry et al., 2013; Ruefle et al., 2014; Vincze, 2016; Harichandran et al., 2016; Forensic Focus survey 2016 & 2018, Stamaugh, 2000; Garfinkel, 2000)

[2] (Vishik & Heisel, 2015; Zan & di Franco, 2020)

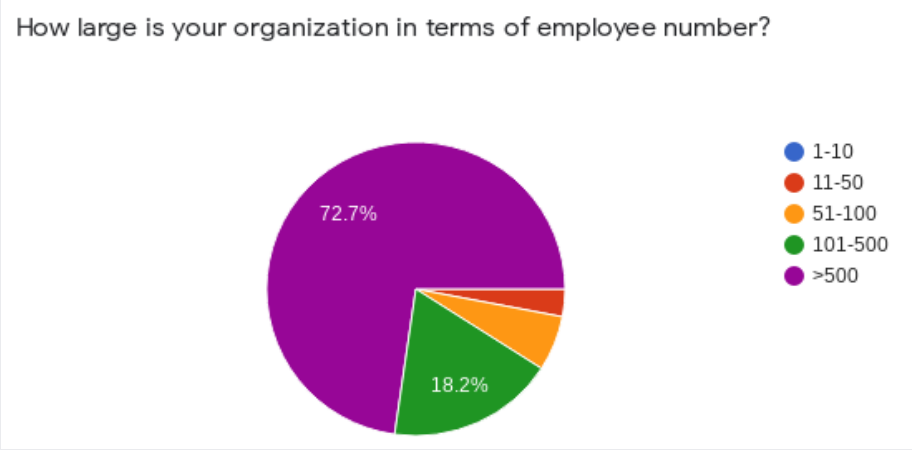
Our Roadmap

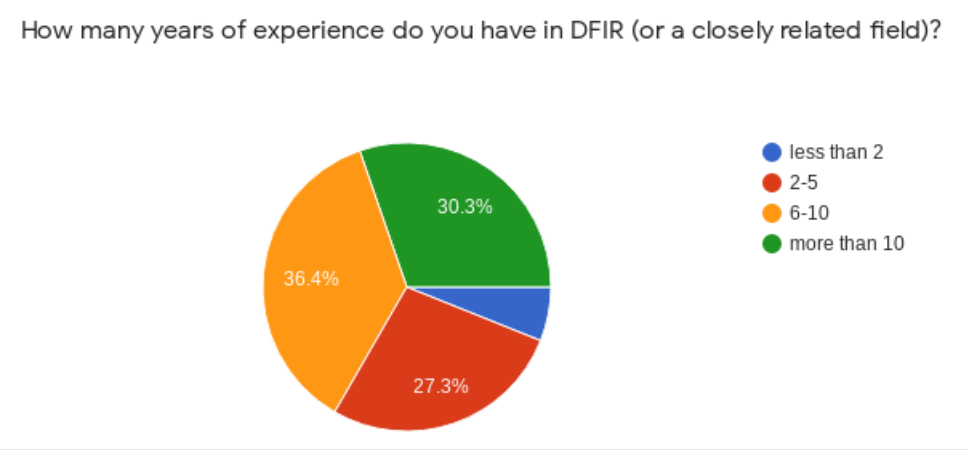
1. **Identify the essential DFIR skills based on:**
   - Expert survey: "What do experts think is needed?"
   - Analysis of existing training courses: "What is currently being taught?"
   - Analysis of job listings: "What the market demands?"
2. **Create a map of these skills to:**
   - Answer what skill domains are the most crucial
   - Provide tips for creating new traning courses & adjusting existing ones
3. **Develop a "pilot" training course** (in progress)
   - Theoretical part
   - Hands-on labs
4. **Share it with the public and make a "test run"** (planned for 2022/2023)
   - a semester course or 1-week intense seminar

https://sites.google.com/vutbr.cz/dfir-alliance

Survey of DFIR Practitioners

- 15 questions (Open-ended, Multi-choice, Y/N)
- Survey was sent to 40 practitioners from countries around the EU:
  - Germany, Austria, Ireland, Netherlands, Czech Republic, Liechtenstein, ...
- 32 respondents:
  - 34% - Law enforcement / Government agencies
  - 66% - Private sector (Hi-tech, Forensics consulting, Engineering, Financial, Health Care, Logistics, Manufacturing, Retail, ...)





Survey of DFIR Practitioners

How did you get your experience/knowledge and how you stay up to date? [OE]

- 50% - academic qualification in fields related to cybersecurity / forensics
- 88% - non-academic training
  - 53% - Vendor-neutral training by SANS, etc.
  - 19% - Vendor-specific training
  - 16% - In-house training & discussion with colleagues
- 63% - self-learning from conference & journal papers
- 22% - learning on the job
- 16% - capture-the-flag competitions, hackatons, etc.
- 16% - community interaction

Survey of DFIR Practitioners

Which 5 skills are the most essential on a daily basis? [OE]

- Hard skills
  - 44% - Knowledge of software & scripting
  - 40% - Knowledge of computer networks
  - 21% - Ability to use general forensics tools
  - ...
- Soft skills
  - 31% - communication (written & verbal)
  - 13% - critical thinking
  - 13% - attention to detail
  - ...

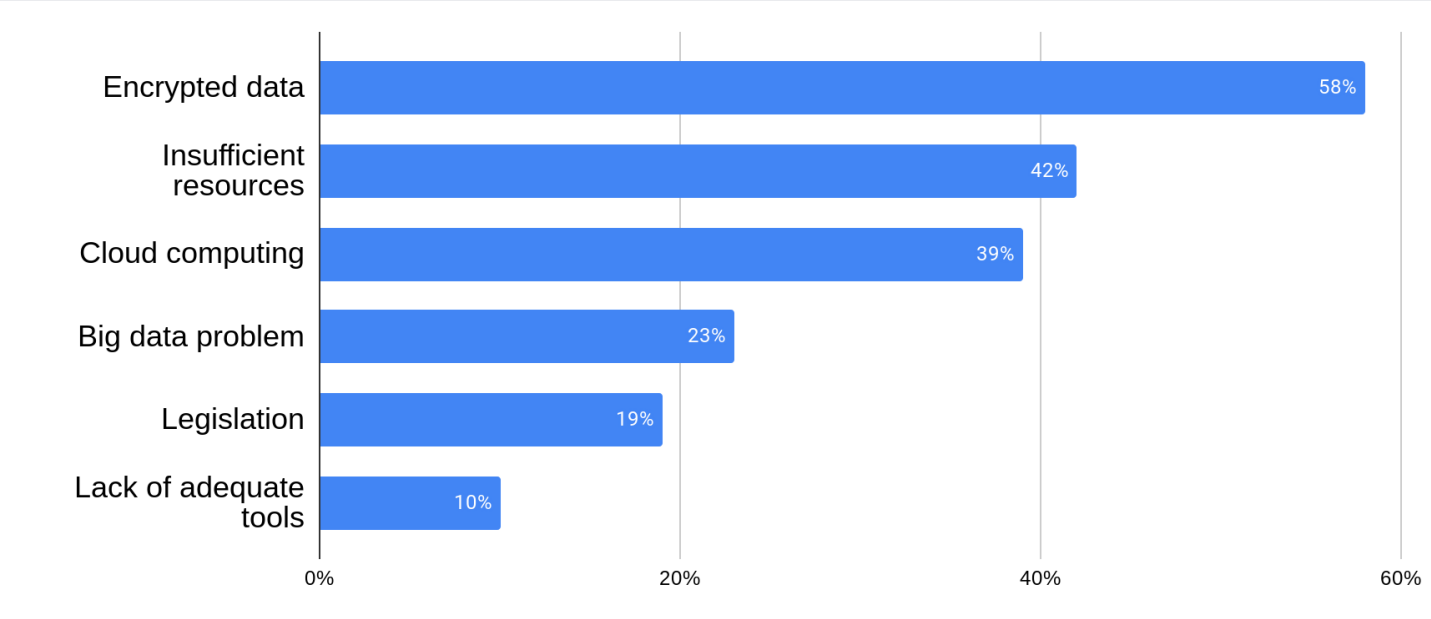
Survey of DFIR Practitioners

What tools and technologies do you primarily use? [OE]

- 99 different tools identified
- The TOP were:
  - 19% - Autopsy
  - 16% - EnCase
  - 16% - Linux utilities
  - 16% - Self-built tools & scripts
  - 9% - Splunk, Wireshark, Volatility framework
- Other repeated answers:
  - AccessData FTK Imager, Moloch, X-Ways, EDRs, Ghidra, IDA, KAPE/Zimmerman, Magnet, MISP, NetworkMiner, NUIX, Renmux, SIFT, Zeek, ...

Survey of DFIR Practitioners

What are the primary challenges you face in your investigations? [OE]



Challenges appearing in 10%+ responses

Analysis of DFIR Courses

Methodology

1. Collection
   - Keyword-based search: "DFIR, Digital Forensics, Incident Response, Course, Training, Education, …"
   - 42 courses
2. Initial assessment
   - Filtered to results that: a) were legitimate, b) provided sufficient level of detail to extract information
   - Reduced to 37 courses (17 academic; 20 private sector: SANS, IACIS, Udemy, ...)
3. Manual analysis
   - Review of courses (topics, description, curricula, …)
   - Identification of most frequently taught skills

Analysis of DFIR Courses

Findings

- Only few courses explicitly advertise themselves as Incident Response
- Majority were part of broader education programs
- Academia
  - Focus on DFIR is more frequent in MSc programs then BSc
  - Most programs (BSc, MSc) do not have a dedicated course on IR but incorporate it into other classes
  - Many universities at least offer 1-2 courses related to DF
- Private sector
  - Majority require fundamental knowledge from computer science & security
  - These prerequsites have to be acquired beforehand
  - Typical duration: 2 to 6 days of training

Analysis of DFIR Courses

Skills

- Most frequent
  - 73% - Investigation Techniques (DF process, methodology, …)
  - 65% - Network Forensics (traffic capturing, protocols, device analysis)
  - 57% - OS Forensics (mobile devices, Windows, Linux, Mac OS X)
  - 57% - Data Acquisition
- Other findings
  - Legal issues (22%), Ethical aspects (19%), Standards (3%) were often not part of the courses
  - Newer topics like IoT Forensics (5%) & Cloud Forensics (3%) were seen very rarely

Job Listings Review

Methodology

1. Selection
   - Keyword-based search on LinkedIn from January 25th to 31st 2021
   - Initial search revealed from 200 to 22 000 jobs worldwide (depending on keywords used)
   - Downloaded several listings per region (EU states, Switzerland, USA)
   - Deleted non-English listings
2. Collection
   - Data set: JobID, date, comany name, industry, location, description, required skills, required qualification
   - Removed listings that were too general or not related to DFIR domain
   - Resulting in 66 job listings
3. Analysis:
   - Manual examination of listings
   - Evaluation of required skills

Job Listings Review

Findings

- Most jobs in major cities, some offered remote work
- Many from well-known tech organizations like Facebook, CrowdStrike, Amazon, …
- Education requirements
  - 48% - at least BCs degree in computer science; 5% MSc; 3% PhD
  - 44% - did not mention specific requirements (especially bigger corporations)
  - 15% - required certification from GIAC, CISSP, etc.
  - Many state equivalent practical experience is equally valued
- Most asked for experience
  - Even for entry-level positions
  - Offers for internships are generally very low

Job Listings Review

- Mostly required hard skills
  - Incident Handling (79%)
  - Data Analysis (42%)
  - Security Event & Incident Logging (39%)
  - Network Forensics (38%)
  - Data Acquisition (18%)
- Majority required proficiency general-purpose scripting languages
  - Python, PowerShell, Ruby, Perl, Bash, …
- Soft skills required
  - Mostly overlapping: Analytic & logical thinking, being a team player, flexibility, discretion, …
  - Strong interest in DFIR or related fields
  - Proficiency in English (written & spoken)

DFIR Skillmap

Methodology

1. Classification of skills
   - Tree[1] of 132 skills in four levels (L1 to L4) with DFIR as root (L1)
   - Second level (L2) has 14 skills, inspired my the ACM Computing Classification System[2]
   - Other sources: scientific papers, courses, teaching programs, websites, blogs, ...
2. Creation of the skill matrix
   - Each row represents a skill
   - Each column stands for a data record (R_1, R_2, …)
   - 32 survey answers, 37 courses, 66 job listings
   - "X" is a match
   - Match for a skill triggers a match for the upper-level skill in the same column

Skills	R_1	R_2	R_3	R_4	R_5	R_6	R_7	R_8	...
DFIR	X	X	X	X	X	X	X	X	...
– L2 skill	X		X	X	X		X	X	...
—- L3 skill			X	X			X		...
—- L3 skill	X		X	X	X			X	...
—— L4 skill					X			X	...
—— L4 skill	X		X	X					...
– L2 skill	X	X	X		X	X		X	...
—- L3 skill			X			X			...
—- L3 skill					X			X	...
...	...	...	...	...	...	...	...	...	...

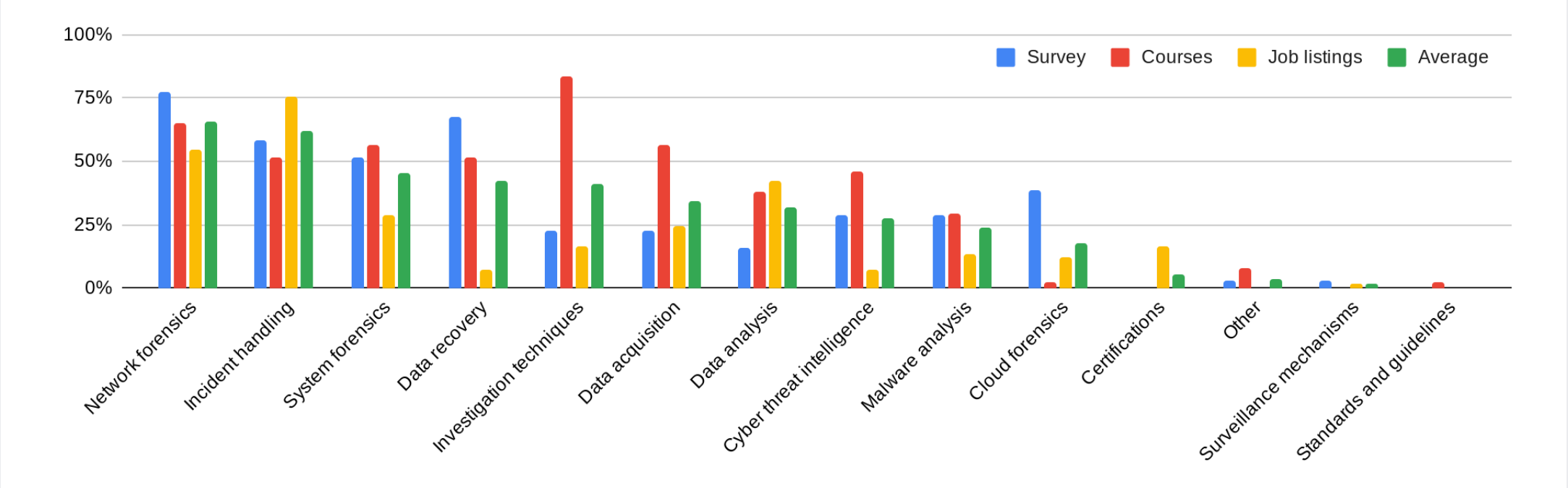
3. Assesment
   - For each skill, we calculated the percentage of matches in: **survey answers, courses, job listings**
   - **Average match ratio** used to estimate each skill's overall importance

[1] Complete tree available at: https://sites.google.com/vutbr.cz/dfir-alliance/documents

[2] See https://dl.acm.org/ccs

Results

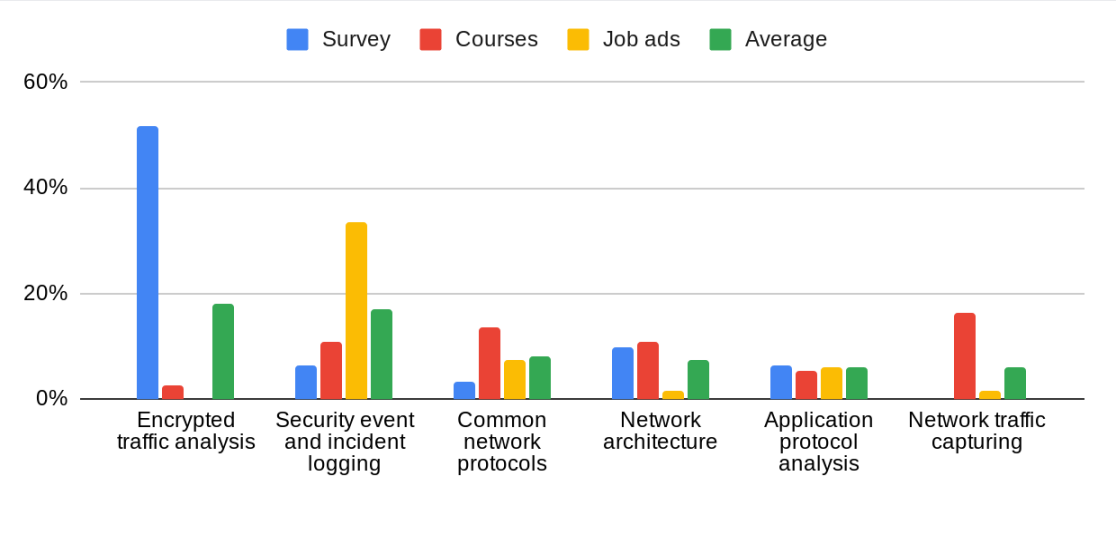
The ranking of L2 skills:



Complete skillmap available at: https://sites.google.com/vutbr.cz/dfir-alliance/documents

Network Forensics

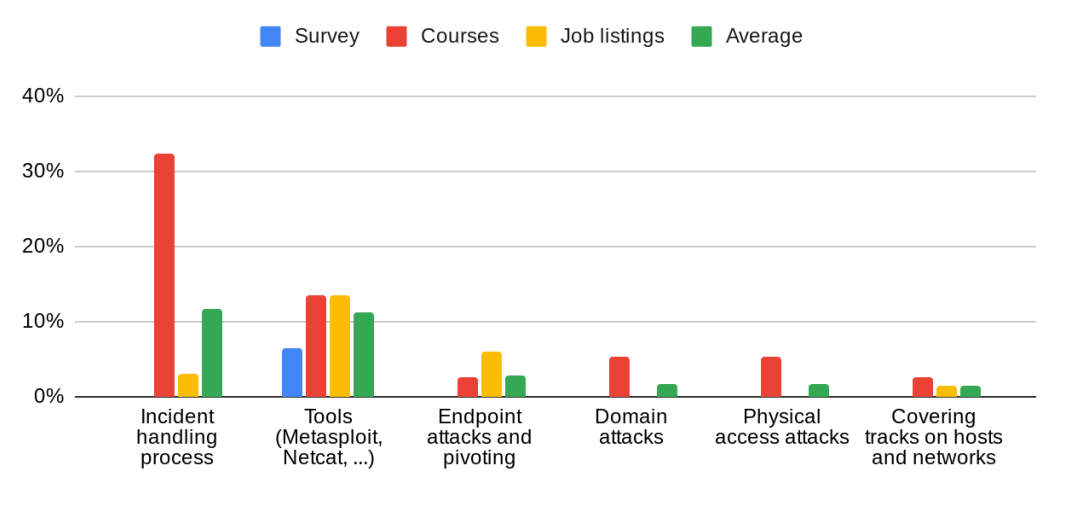
- Encrypted traffic analysis – big challenge, rarely covered by courses
- Security event & incident logging – high demand, poor offerring in courses



Top L3 skills in Network Forensics

Incident Handling

- Frequently mentioned in both job listings & survey answers
  - Job listings are more concrete
  - Survey provides very little information about what particular L3 skills are needed most
- Area seems to be fairly covered by existing courses



Top L3 skills in Incident Handling

System Forensics

- Windows Forensics is the most wanted (70% of desktop market share)
- Linux Forensics are the 2nd (major OS on servers)
- What's about Mobile Forensics?
  - Existing courses cover this area more than other systems
  - 0% demand in job listings
  - Is the importance of this area overrated?

Top L3 skills in System Forensics

Conclusion

- Much of existing courses' content is still relevant, but there are gaps to be filled
- Significant difference between professionals' opinions on required skills and the contents of courses, e.g. analysis of encrypted data
- Most employers want previous work experience in the domain
- Importance of hand-on training
- Soft skills were also frequently mentioned and are equally important