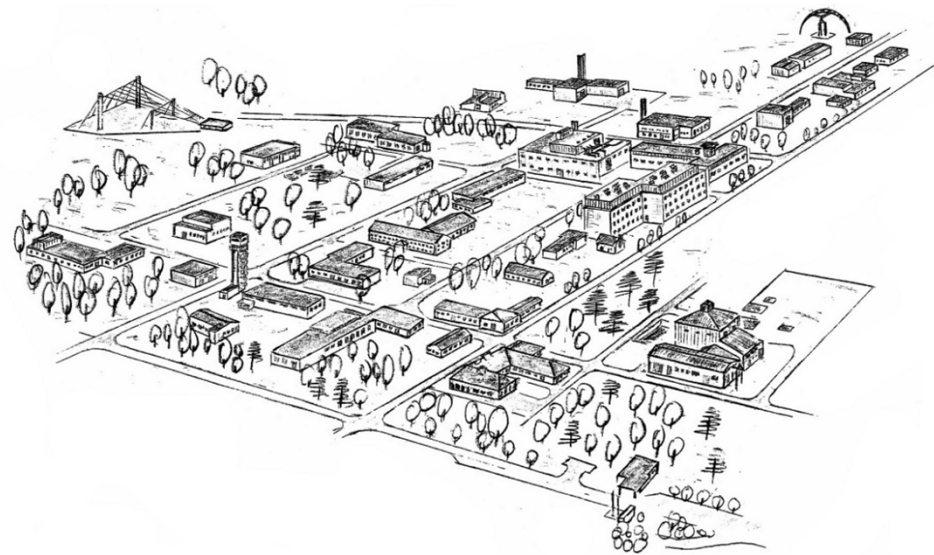# Heuristic Approach to Evaluate the Occurrence of IEMI Sources in Criminal Activities

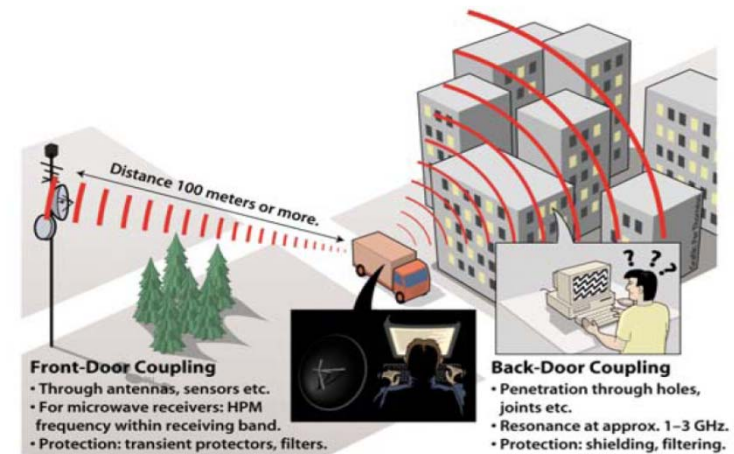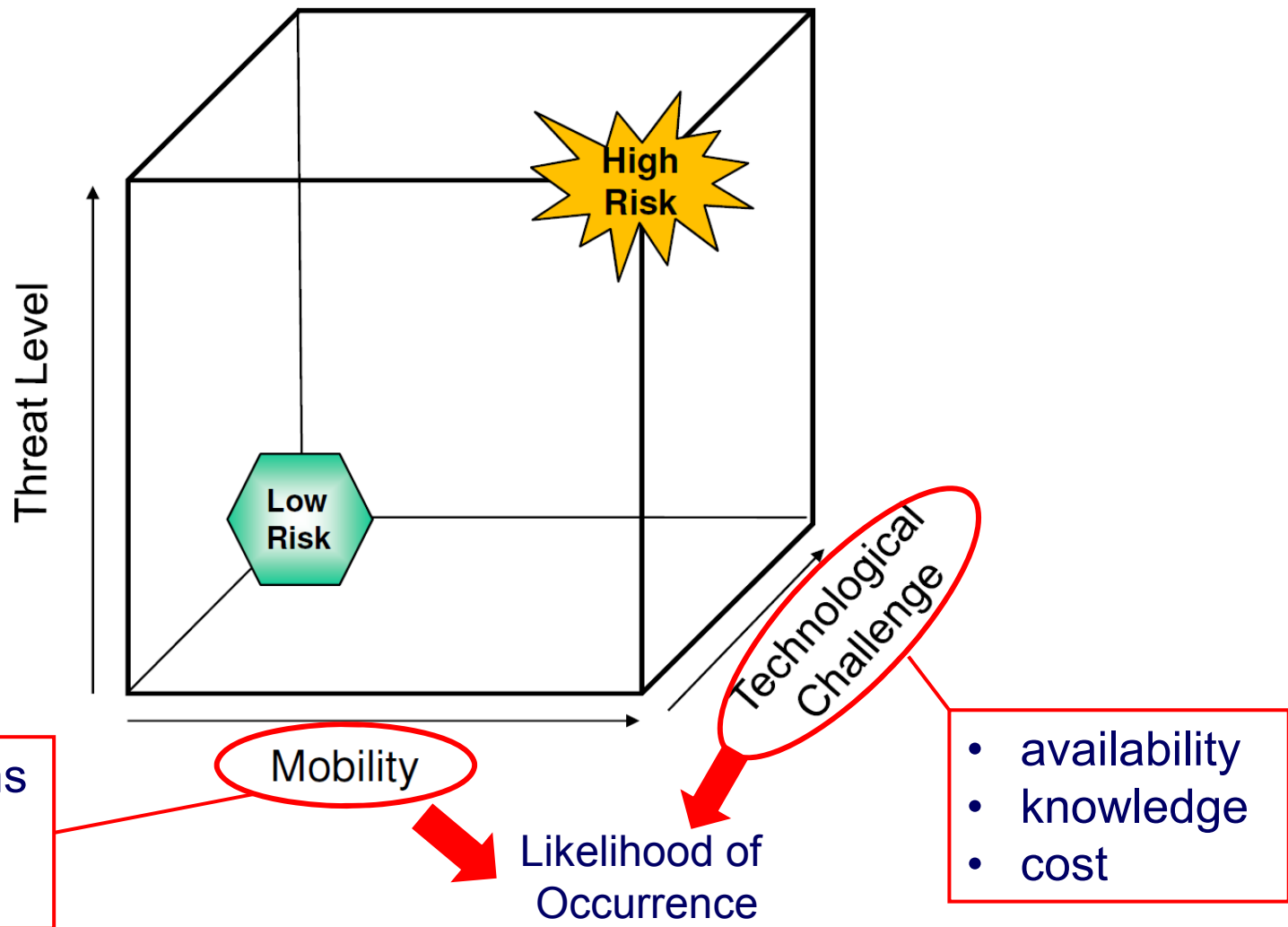*F. Sabath* and *H. Garbe*

1. Introduction

2. Risk assessment cube

3. Likelihood of occurrence

   3.1 Availability

   3.2 Knowledge / Skills

   3.3 Cost

4. Example

5. Conclusion

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- Technological progress of the last decade enables the design and assembly of powerful HPEM sources

- HPEM like sources and components are available on the free market

- Increasing vulnerability of electronic and electric systems to HPEM environments

- Various scientific investigations focused on IEMI caused effects

- Current questions:

  Possibility that a given HPEM environment occurs

Distance 100 meters or more.

Front-Door Coupling
- Through antennas, sensors etc.
- For microwave receivers: HPM frequency within receiving band.
- Protection: transient protectors, filters.

Back-Door Coupling
- Penetration through holes, joints etc.
- Resonance at approx. 1–3 GHz.
- Protection: shielding, filtering.

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Risk assessment cube

- dimensions
- weight
- supplies

Mobility

Likelihood of Occurrence

- availability
- knowledge
- cost

Threat Level

Technological Challenge

High Risk

Low Risk

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P_O	Probability Category		Description
0-1	Improberable/ Unlikely	< 1%	So unlikely, it can be assumed that the IEMI source does not occur.
2 - 3	Remote	1% - 5%	Unlikely, but it is possible that the IEMI source occurs in an IEMI Event.
4 – 6	Occasional	5% - 50%	IEMI source will occur sometimes
7 – 8	Proberable	50% - 90%	IEMI source will occur in more than half of the IEMI attacks
9 - 10	Frequent	>90%	Most likely that the IEMI source will occur in approximately every attack

Scale for the Availability

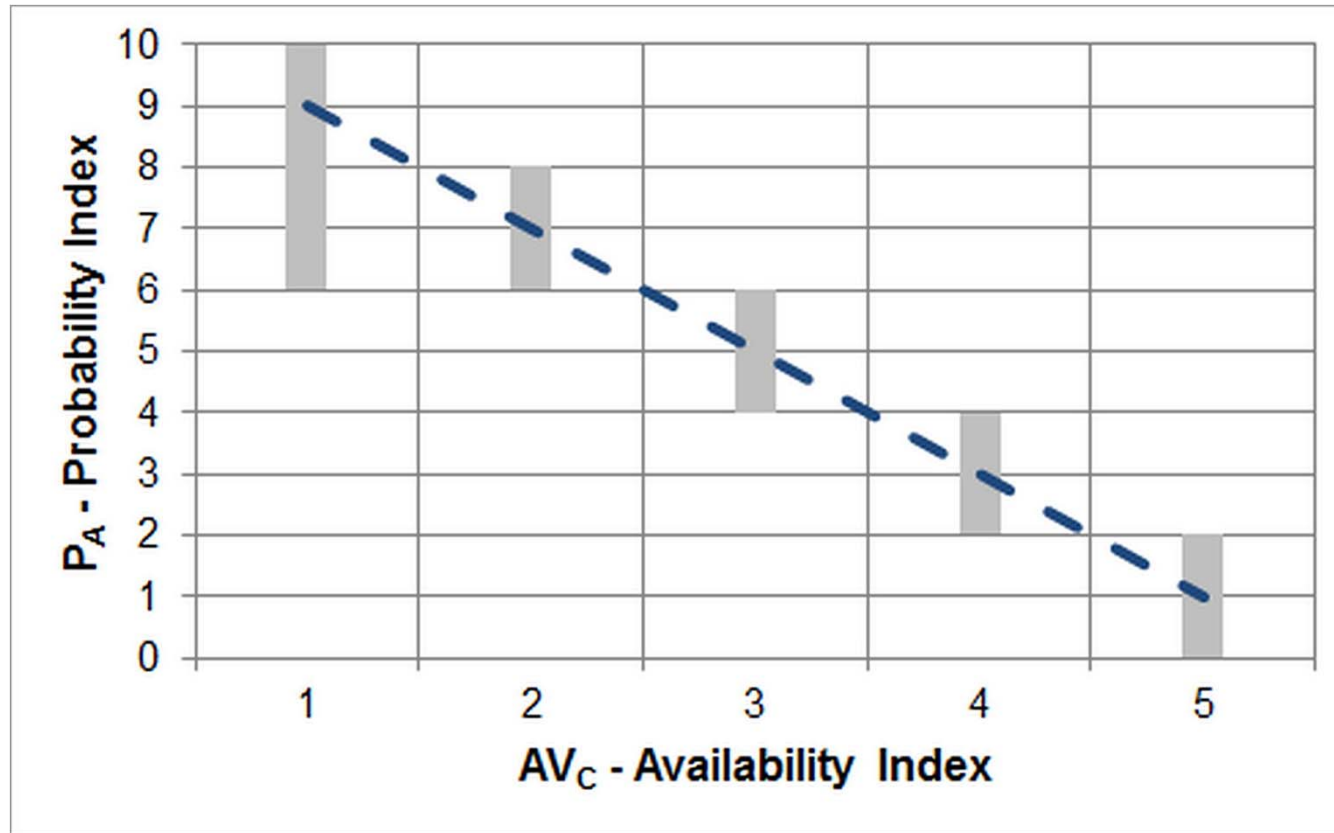| AV_C	Availability Category	Description
1	of-the-shelf	available in the commercial market-place (e.g. department stores); can be bought by anyone
2	commercially available	available in specialty stores; can be bought by anyone
3	specialized trade	available only in specialized trading companies; acquisition is limited to commercial customer
4	limited acquisition	Limited acquisition under conditions or to registered buyer, special designed components
5	restricted acquisition	trade or acquisition prohibited by law

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- stochastic analysis
  - extrapolation of historical data (experiences)
  - quantitative results (percentage numbers)

- predictive techniques
  - qualitative

- expert judgments
  - qualitative
  - discrete scale

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Mapping of the availability on the probability

$$P_A = 11 - 2AV_C$$

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Scale for the Knowledge

K_D, K_O	Knowledge Category	Description
1	novice	general knowledge
2	skilled	basic understanding
3	specialist	specialized knowledge and expertise
4	graduate	academic knowledge and professional expertise
5	expert	expert knowledge and profound expertise

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$$P_K = 10 - \frac{7}{5}K_D$$

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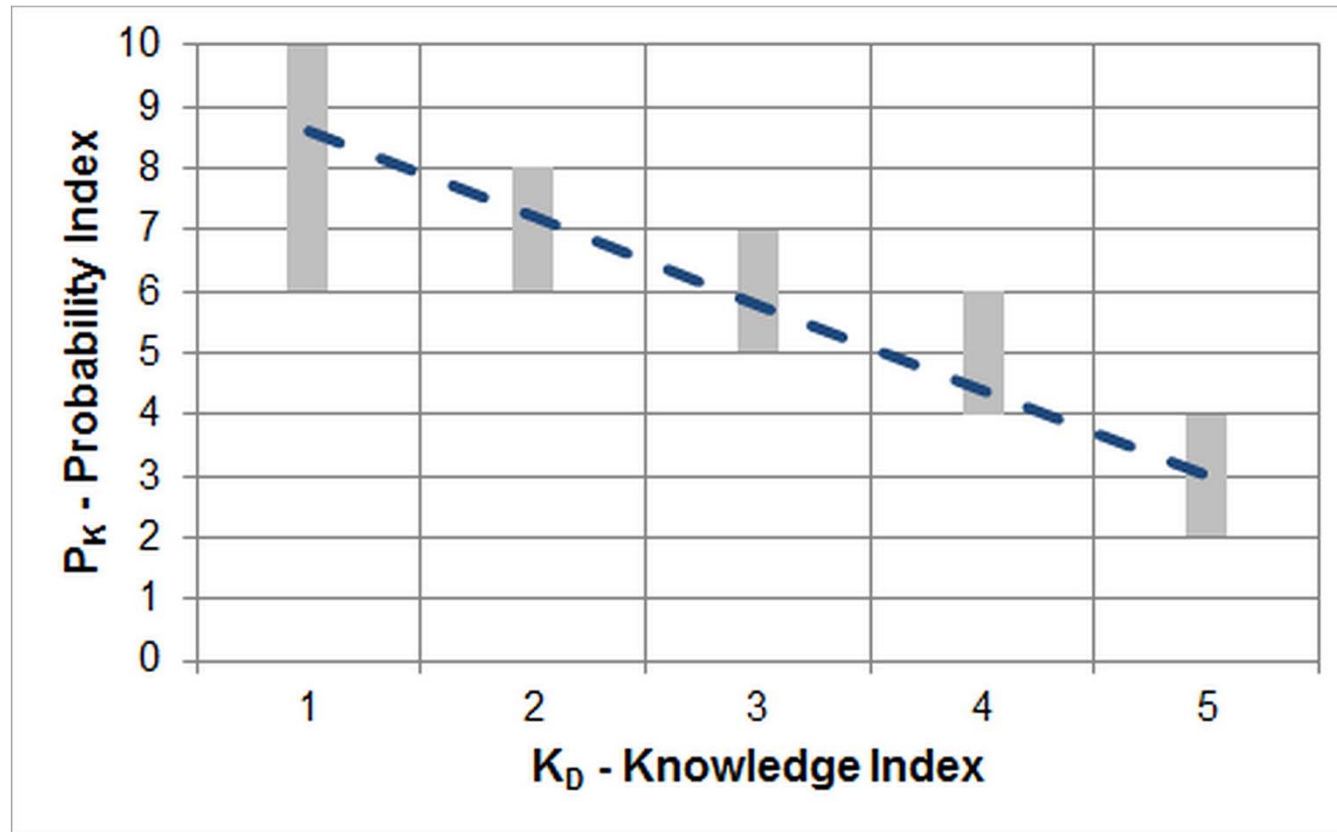
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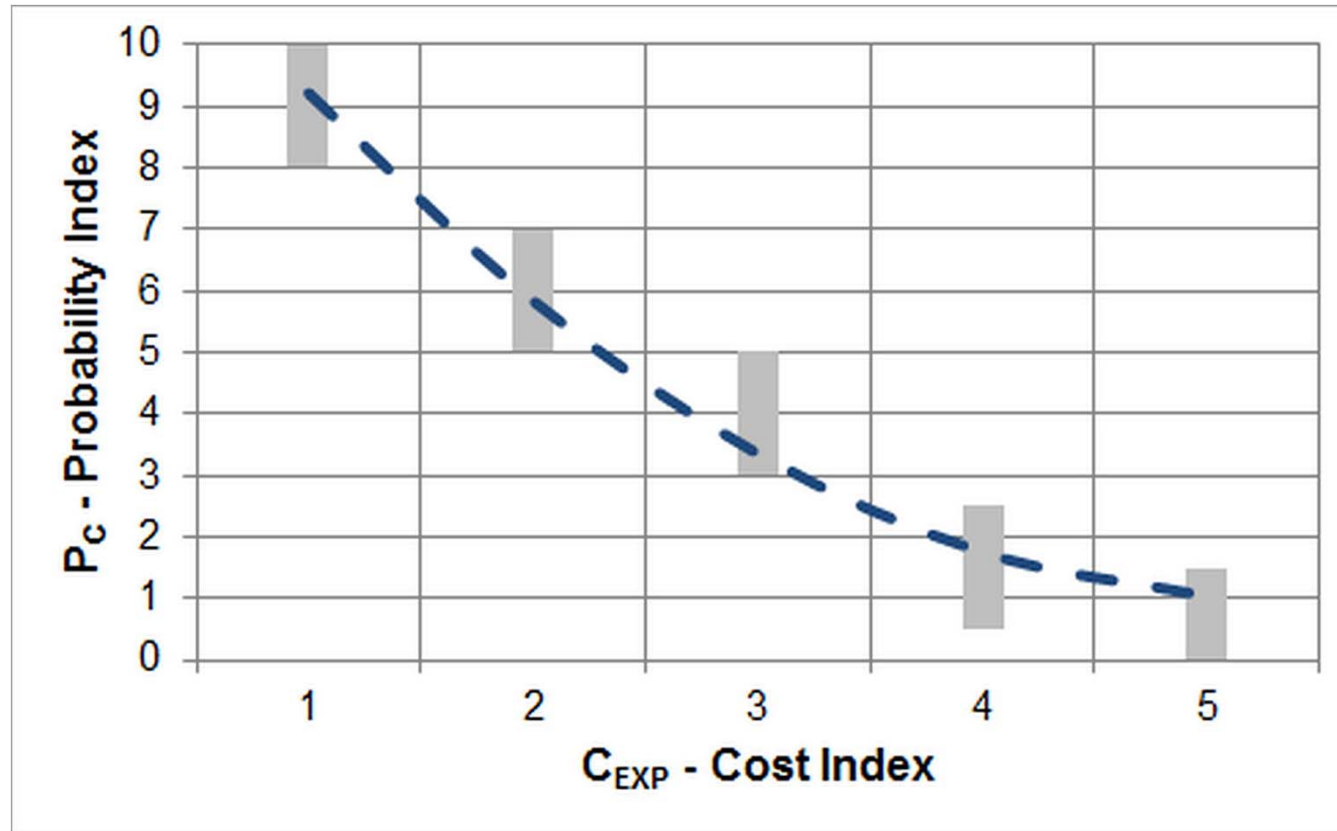
Scale for the Cost

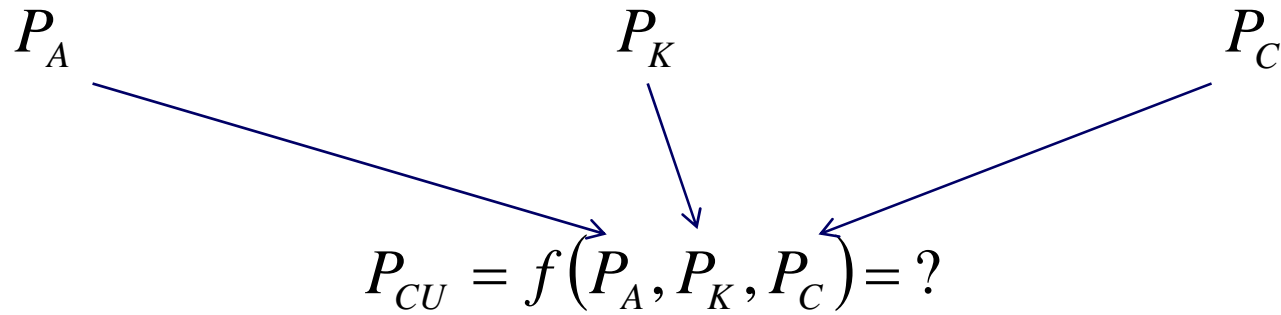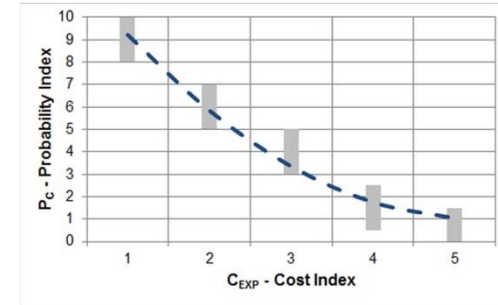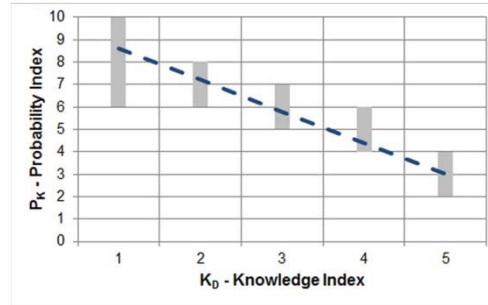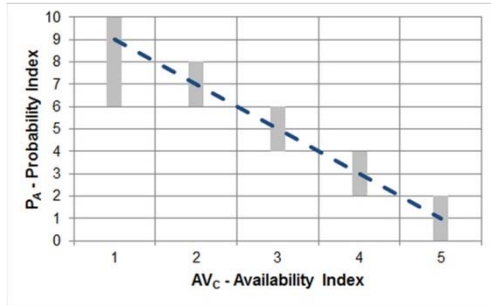| C_{EXP}	Category	Description
1	Low Cost	< 1.000 €
2	Moderate Cost	1.000 – 10.000 €
3	Increased Cost	10.000 – 100.000 €
4	High Cost	0,1 – 1 Mio €
5	Extreme Cost	> 1 Mio €

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$$P_C = 1 + \frac{(5{,}3 - C_{EXP})^2}{2{,}25}$$

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$$P_A \qquad\qquad P_K \qquad\qquad P_C$$

$$P_{CU} = f(P_A, P_K, P_C) = ?$$

$$P_{CU} = \sqrt[3]{P_A \cdot P_K \cdot P_C}$$

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assembled by a skilled person

$K_D = 2$		AV_C				
		1	2	3	4	5
C_{exp}	1	8,42	7,74	6,92	5,84	4,05
	2	7,23	6,65	5,95	5,02	3,48
	3	6,01	5,53	4,94	4,17	2,89
	4	4,84	4,45	3,98	3,36	2,33
	5	4,07	3,74	3,35	2,82	1,96

assembled by a graduate

$K_D = 4$		AV_C				
		1	2	3	4	5
C_{exp}	1	7,15	6,57	5,88	4,96	3,44
	2	6,14	5,64	5,05	4,26	2,95
	3	5,10	4,69	4,19	3,54	2,45
	4	4,11	3,78	3,38	2,85	1,98
	5	3,45	3,18	2,84	2,39	1,66

orange: probable occurrence;
yellow: occasional occurrence,
green: remote occurrence

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Example: JOLT

Parameter	Value	Description
Far radiated voltage		$r \cdot E_{peak} \leq 5{,}3 MV$
Waveform		Pulse (differentiated double exponential)
PRF		600 Hz
Availability of components	$AV_C = 4$	limited acquisition and special design
knowledge needed for design and assembling	$K_D = 4$	graduate engineer
Cost	$C_{EXP} = 4$	100.000 – 1.000.000 €
Likelihood of Criminal Use	$P_{CU} = 2{,}8$	IEMI source will occur in some IEMI events
Mobility	$M = 3$	trailer based system < 10 m^3

- a heuristic technique for the assessment of the likelihood of criminal and terrorist offender obtain access to a given IEMI sources is presented.
  - availability of the source or its components,
  - Required knowledge level
  - cost
  - mobility
- The capability to assess existing IEMI sources was demonstrated by applying the derived equation on the JOLT system.

Thank you for your attention

Questions ?

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