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airgap

Air-Gap Research Page

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WIRED: <https://www.wired.com/story/air-gap-researcher-mordechai-guri/>

This page is dedicated to air-gap jumping research

Air-Gap Covert Channels

(below you can find links to papers and videos)

COVID-bit: Keep a Distance of (at least) 2m From My Air-Gap Computer!

Mordechai Guri

Demo video: <https://youtu.be/96eMLEIA57Q>

Paper: <http://arxiv.org/abs/2212.03520>

GAIROSCOPE: Injecting Data from Air-Gapped Computers to Nearby Gyroscopes

Mordechai Guri

Demo video: <https://youtu.be/5sUQ0jG01dw>

Paper: <http://arxiv.org/abs/2208.09764>

Paper: <https://ieeexplore.ieee.org/document/9647842>

LANTENNA: Exfiltrating Data from Air-Gapped Networks via Ethernet Cables

Mordechai Guri

2021 IEEE 45th Annual Computers, Software, and Applications Conference (COMPSAC)

Demo video: <https://youtu.be/-X2Mb5HWE44>

Paper: <http://arxiv.org/abs/2110.00104>

Paper: <https://ieeexplore.ieee.org/document/9529607>

SATAn: Air-Gap Exfiltration Attack via Radio Signals From SATA Cables

Mordechai Guri

2022 19th Annual International Conference on Privacy, Security & Trust (PST)

Demo video: <https://www.youtube.com/watch?v=rlmP-csuFlo>

Paper: <http://arxiv.org/abs/2207.07413>

Paper: <https://ieeexplore.ieee.org/document/9851978>

ETHERLED: Sending Covert Morse Signals from Air-Gapped Devices via Network Card (NIC) LEDs

2022 IEEE International Conference on Cyber Security and Resilience (CSR)

Mordechai Guri

Demo video: https://www.youtube.com/watch?v=acYAPMr_JZg

Paper: <https://arxiv.org/abs/2208.09975>

Paper: <https://ieeexplore.ieee.org/document/9850284>

AIR-GAP APT (USB-Borne)

USBCulprit: USB-borne Air-Gap Malware

EICC: European Interdisciplinary Cybersecurity Conference, November 2021

Paper: <https://dl.acm.org/doi/abs/10.1145/3487405.3487412>

AIR-FI: Leaking Data from Air-Gapped Computers Using Wi-Fi Frequencies

M. Guri, "AIR-FI: Leaking Data from Air-Gapped Computers Using Wi-Fi Frequencies," in IEEE Transactions on Dependable and Secure Computing, 2022, doi: 10.1109/TDSC.2022.3186627.

Paper: <https://ieeexplore.ieee.org/document/9808153>

Demo video: <https://www.youtube.com/watch?v=vhNnc0ln63c>

DOI: 10.1109/TDSC.2022.3186627

Air-Fi: Generating Covert Wi-Fi Signals from Air-Gapped Computers

Mordechai Guri

Paper: <https://arxiv.org/abs/2012.06884>

Demo video: <https://www.youtube.com/watch?v=vhNnc0ln63c>

POWER-SUPPLaY: Leaking Data from Air-Gapped Systems by Turning the Power-Supplies Into Speakers

M. Guri, "POWER-SUPPLaY: Leaking Sensitive Data from Air-Gapped, Audio-Gapped Systems by Turning the Power Supplies into Speakers," in IEEE Transactions on Dependable and Secure Computing, doi: 10.1109/TDSC.2021.3133406.

Paper: <https://ieeexplore.ieee.org/document/9640597>

Paper: <https://arxiv.org/abs/2005.00395>

Demo video 1: <https://www.youtube.com/watch?v=VTTq-wBFu-o>

AiR-ViBeR: Exfiltrating Data from Air-Gapped Computers via Covert Surface ViBrAtIoNs

Mordechai Guri Exfiltrating data from air-gapped computers via ViBrAtIoNs. Future Gener. Comput. Syst. 122: 69-81 (2021)

Paper: <https://www.sciencedirect.com/science/article/abs/pii/S0167739X21001151>

Paper: <https://arxiv.org/abs/2004.06195v1>

Demo video: <https://youtu.be/XGD343nq1dg>

BRIGHTNESS: Leaking Sensitive Data from Air-Gapped Workstations via Screen Brightness

Mordechai Guri, Dima Bykhovsky, Yuval Elovici

2019 12th CMI Conference on Cybersecurity and Privacy (CMI)

Demo Video: <https://youtu.be/ZrkZUO2g4DE>

(In this demo, the screen secretly exfiltrate the text of "Winnie-the-Pooh" by A.A. Milne)

Paper: <https://arxiv.org/abs/2002.01078>

Paper: <https://ieeexplore.ieee.org/document/8962137>

Black Hat USA: Mordechai Guri Briefing "The Air-Gap Jumpers"

Link: [The Air-Gap Jumpers](#)

Presentation: <https://i.blackhat.com/us-18/Wed-August-8/us-18-Guri-AirGap.pdf>

BlackHat Video: <https://www.youtube.com/watch?v=YKRtFgunyj4>

BeatCoin: Leaking Private Keys from Air-Gapped Cryptocurrency Wallets, Mordechai Guri

2018 IEEE International Conference on Internet of Things (iThings) and IEEE Green Computing and Communications (GreenCom) and IEEE Cyber, Physical and Social Computing (CPSCom) and IEEE Smart Data (SmartData)

Paper: <https://ieeexplore.ieee.org/document/8726762>

Paper: <https://arxiv.org/pdf/1804.08714.pdf>

Video 1: <https://youtu.be/ddmHOvT866o>

Video 2: <https://youtu.be/2WtiHZNeveY>

Read our new article in the Communication of the ACM (CACM), April 2018:

Bridgware: The Air-Gap Malware

By Mordechai Guri, Yuval Elovici

Communications of the ACM, Vol. 61 No. 4, Pages 74-82

Paper: <https://dl.acm.org/citation.cfm?id=3177230>

PowerHammer (exfiltrating data through power lines)

Guri M, Zadov B, Bykhovsky D, Elovici Y. **PowerHammer: Exfiltrating data from air-gapped computers through power lines**. IEEE Transactions on Information Forensics and Security. 2019 Nov 7.

Paper (IEEE): <https://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=8894040>

Paper (arXiv version): <https://arxiv.org/abs/1804.04014>

MOSQUITO (Acoustic)

"**MOSQUITO: Covert Ultrasonic Transmissions between Two Air-Gapped Computers using Speaker-to-Speaker Communication**", Mordechai Guri, Yosef Solewicz, Yuval Elovici

2018 IEEE Conference on Dependable and Secure Computing (DSC)

Paper: <https://ieeexplore.ieee.org/document/8625124>

Video 1: <https://www.youtube.com/watch?v=ZD8CNxYe5dk>

Video 2: https://www.youtube.com/watch?v=O_jz2mDwAew

ODINI (Magnetic)

"**ODINI : Escaping Sensitive Data from Faraday-Caged, Air-Gapped Computers via Magnetic Fields**", Mordechai Guri, Boris Zadov, Yuval Elovici

IEEE Transactions on Information Forensics and Security, 2019

Paper: <https://ieeexplore.ieee.org/document/8820015> (IEEE Open Access)

Video: <https://www.youtube.com/watch?v=h07iXD-aSCA>

DOI: [10.1109/TIFS.2019.2938404](https://doi.org/10.1109/TIFS.2019.2938404)

MAGNETO (Magnetic)

"**MAGNETO: Covert Channel between Air-Gapped Systems and Nearby Smartphones via CPU-Generated Magnetic Fields**", Mordechai Guri
Future Generation Computer Systems (FGCS) Volume 115, February 2021, Pages 115-125

Paper: <https://doi.org/10.1016/j.future.2020.08.045>

Video: <https://www.youtube.com/watch?v=yz8E5n1Tzlo>

AirHopper (Electromagnetic)

Mordechai Guri, Gabi Kedma, Assaf Kachlon, and Yuval Elovici. "**AirHopper: Bridging the air-gap between isolated networks and mobile phones using radio frequencies.**" In Malicious and Unwanted Software: The Americas (MALWARE), 2014 9th International Conference on, pp. 58-67. IEEE, 2014.

<http://ieeexplore.ieee.org/document/6999418/>

Guri, Mordechai, Matan Monitz, and Yuval Elovici. "**Bridging the Air Gap between Isolated Networks and Mobile Phones in a Practical Cyber-Attack.**" ACM Transactions on Intelligent Systems and Technology (TIST) 8, no. 4 (2017): 50.

Paper: <https://dl.acm.org/citation.cfm?id=2870641>

Demo video: <https://www.youtube.com/watch?v=2OzTWiGl1rM&t=20s>

BitWhisper (Thermal)

Mordechai Guri, Matan Monitz, Yisroel Mirski, and Yuval Elovici. "**Bitwhisper: Covert signaling channel between air-gapped computers using thermal manipulations.**" In Computer Security Foundations Symposium (CSF), 2015 IEEE 28th, pp. 276-289. IEEE, 2015.

Paper: <http://ieeexplore.ieee.org/document/7243739/>

Demo video: <https://www.youtube.com/watch?v=EWRk51oB-1Y&t=15s>

GSMem (Electromagnetic)

Mordechai Guri, Assaf Kachlon, Ofer Hasson, Gabi Kedma, Yisroel Mirsky, and Yuval Elovici. "**GSMem: Data exfiltration from air-gapped computers over gsm frequencies.**" In 24th USENIX Security Symposium (USENIX Security 15), pp. 849-864. 2015.

Paper: <https://www.usenix.org/node/190937>

Demo video: <https://www.youtube.com/watch?v=RChj7Mg3rC4>

DiskFiltration (Acoustic)

Mordechai Guri, Yosef Solewicz, Andrey Daidakulov, Yuval Elovici. "**Acoustic Data Exfiltration from Speakerless Air-Gapped Computers via Covert Hard-Drive Noise ('DiskFiltration')**". European Symposium on Research in Computer Security (ESORICS 2017) pp 98-115

Paper: https://link.springer.com/chapter/10.1007/978-3-319-66399-9_6

Demo video: <https://www.youtube.com/watch?v=H7lQXmSLiP8>

USBee (Electromagnetic)

Mordechai Guri, Matan Monitz, and Yuval Elovici. "**USBee: Air-Gap Covert-Channel via Electromagnetic Emission from USB.**" Privacy, Security and Trust (PST), 2016 14th Annual Conference on

Paper: <http://ieeexplore.ieee.org/document/7906972/>

Demo video: <https://www.youtube.com/watch?v=E28V1t-k8Hk>

LED-it-GO (Optical)

Mordechai Guri, Boris Zadov, Yuval Elovici. "**LED-it-GO: Leaking (A Lot of) Data from Air-Gapped Computers via the (Small) Hard Drive LED**". Detection of Intrusions and Malware, and Vulnerability Assessment - 14th International Conference, DIMVA 2017: 161-184

Paper: <https://www.springerprofessional.de/en/led-it-go-leaking-a-lot-of-data-from-air-gapped-computers-via-th/12476142>

Demo video: <https://www.youtube.com/watch?v=4vlu8ld68fc>

Fansmitter (Acoustic)

Mordechai Guri, Yosef Solewicz, Andrey Daidakulov, and Yuval Elovici. "**Fansmitter: Acoustic Data Exfiltration from (Speakerless) Air-Gapped Computers.**" arXiv preprint arXiv:1606.05915 (2016).

Paper: <https://arxiv.org/abs/1606.05915>

Demo video: https://www.youtube.com/watch?v=v2_sZlfZkDQ

Guri, Mordechai, Yosef Solewicz, and Yuval Elovici. "**Fansmitter: Acoustic data exfiltration from air-Gapped computers via fans noise.**" Computers & Security 91 (2020): 101721.

Paper: <https://doi.org/10.1016/j.cose.2020.101721>

aiR-Jumper (Optical, Infrared)

"**aiR-Jumper: Covert air-gap exfiltration/infiltration via security cameras & infrared (IR)**" Mordechai Guri, Dima Bykhovsky. Computers & Security (2018).

Paper: <https://doi.org/10.1016/j.cose.2018.11.004>

Video (infiltration): <https://www.youtube.com/watch?v=auoYKSzdOj4>

Video (exfiltration): <https://www.youtube.com/watch?v=om5fNqKjj2M>

CTRL-ALT-LED (Optical)

CTRL-ALT-LED: Leaking Data from Air-Gapped Computers Via Keyboard LEDs

Mordechai Guri

2019 IEEE 43rd Annual Computer Software and Applications Conference (COMPSAC)

Paper: <https://ieeexplore.ieee.org/document/8754078>

Demo video: <https://youtu.be/1kBGDhVr7x0>

xLED (Optical)

xLED: Covert Data Exfiltration from Air-Gapped Networks via Switch and Router LEDs

Mordechai Guri ; Boris Zadov ; Andrey Daidakulov ; Yuval Elovici

2018 16th Annual Conference on Privacy, Security and Trust (PST)

Paper: <https://ieeexplore.ieee.org/document/8514196>

Demo video: <https://www.youtube.com/watch?v=mSNt4h7EDKo>

VisiSploit (Optical)

Mordechai Guri, Ofer Hasson, Gabi Kedma, and Yuval Elovici. "**An optical covert-channel to leak data through an air-gap.**" In Privacy, Security and Trust (PST), 2016 14th Annual Conference on, pp. 642-649. IEEE, 2016.

Paper: <http://ieeexplore.ieee.org/document/7906933/>

Mordechai Guri, Ofer Hasson, Gabi Kedma, and Yuval Elovici. "**VisiSploit: An Optical Covert-Channel to Leak Data through an Air-Gap.**" arXiv preprint arXiv:1607.03946 (2016).

LCD TEMPEST Air-Gap Attack Reloaded (Electromagnetic)

Mordechai Guri, Matan Monitz

"LCD TEMPEST Air-Gap Attack Reloaded". 2018 IEEE International Conference on the Science of Electrical Engineering in Israel (ICSEE)

Paper: <https://ieeexplore.ieee.org/abstract/document/8646277>

HOTSPOT: Crossing the air-gap between isolated pcs and nearby smartphones using temperature (Thermal)

Mordechai Guri

2019 European Intelligence and Security Informatics Conference (EISIC)

Paper: <https://ieeexplore.ieee.org/abstract/document/9108874/>

Optical air-gap exfiltration attack via invisible images (Optical)

Mordechai Guri

Optical air-gap exfiltration attack via invisible images, Journal of Information Security and Applications

Volume 46, June 2019, Pages 222-230

Paper: <https://doi.org/10.1016/j.jisa.2019.02.004>

Optical Covert Channel from Air-Gapped Networks via Remote Orchestration of Router/Switch LEDs (Optical)

Mordechai Guri

Optical Covert Channel from Air-Gapped Networks via Remote Orchestration of Router/Switch LEDs

European Intelligence and Security Informatics Conference (EISIC), 2018

Paper: <https://ieeexplore.ieee.org/abstract/document/8753035>

CD-LEAK: Leaking Secrets from Audioless Air-Gapped Computers Using Covert Acoustic Signals from CD/DVD Drives (Acoustic)

Mordechai Guri

M. Guri, "CD-LEAK: Leaking Secrets from Audioless Air-Gapped Computers Using Covert Acoustic Signals from CD/DVD Drives," 2020 IEEE 44th Annual Computers, Software, and Applications Conference (COMPSAC), Madrid, Spain, 2020, pp. 808-816, doi: 10.1109/COMPSAC48688.2020.0-163.

Paper: <https://ieeexplore.ieee.org/document/9202547>

