

### ITSECX October 7th 2022

J. Zivanovic M. Leithner D. E. Simos

Motivation

RVM Functionality

Past Attacks

Our Attack

Store Reaction

Other countries

Mitigation

Conclusion

# Reverse Vending Machine (RVM) Exploits Real world exploits / vulnerabilities

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# Overview

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### Motivation

- RVM Functionality
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- Motivation
- How do RVMs work?
- Past Attacks
- Our Attack
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- Other countries
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# $\mathcal{O}_{\text{Research}}^{\text{SBA}}$ Why is this topic interesting?

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- Financial Aspect: Receipts traded for money (Free Money?)
  - Austria plans to **extend it's RVM infrastructure** to accept plastic bottles and cans [1]

# SBA Reverse Vending Process

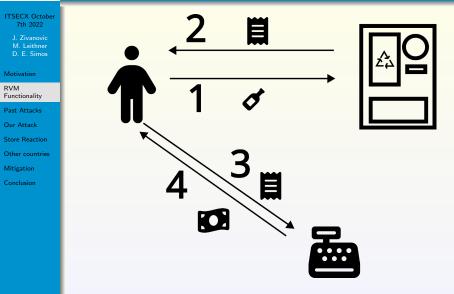


Figure: Visualization of reverse vending process.

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# arch Bottle Detection

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# Barcode Scanner

- Material Detection (IR spectrometer)
- Shape Detection (camera)
- Weight (weight sensor)
- Combination of multiple attributes



# Attacks on RVMs

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#### 365 > VERBRAUCHER NEWS

### Bei Aldi, Lidl, Rewe, Edeka und Co.: So dreist tricksen Betrüger an den Pfandautomaten

24.11.2021 06:12 KONSTANTINOS MITSIS



Pfandbetrug

# Wie aus 25 Cent Millionen Euro werden

10. April 2019, 14:27 Uhr



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### Betrüger erbeutet 44.000 Euro mit einer Pfandflasche

Ein Getränkehändler bereicherte sich um Zehntausende Euro, indem er einen Pfandautomaten manipulierte. Das Amtsgericht Köln hat den Mann nun verurteilt. Sein Trick war recht simpel.

16.11.2016, 17.47 Uhr

Köln

# SBA Inside Attacks / Machine Manipulation **ITSECX** October 7th 2022 J. Zivanovic M. Leithner D. E. Simos Motivation Many different/creative methods (fishing line [4]) Past Attacks Our Attack Usually employee changes machine configuration or interferes Store Reaction with its processing pipeline Other countries Two men in Germany made 115 000€ by not shredding bottles Mitigation and re-returning them [3] Conclusion

## **SBA** Research Attack Bottle Acceptance System

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- Trivial if only barcode scanner used (Aldi Nord: Toilet paper rolls with barcode [4])
- Goal is to make the machine accept products that it would not usually deem valid
- Couple collected bottles from other country
- Bottles not accepted, but they placed barcodes of accepted bottles over original [4]

# **SBA** Research Attack the Bottle Classification System

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- Not really realistic (except if only barcode scanner is used)
- Goal is to get a bottle recognized as something more valuable
- E.g. assume object detection is used to differentiate between bottles and crates
- An attack would be to get a bottle to be recognized as a crate, thus giving the attacker a higher deposit





# Some Collected Receipts - (Store I)

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Figure: Store I receipts for one returned bottle.

# SBA Some Collected Receipts - (Store II)

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Store Reaction Other countries Mitigation

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Conclusion

€0	.09	2 200741 0		€() 2 200741 00	.09
Flaschenteil 1× 0.09 Fl.Bier	0.09	Flaschenteil 1× 0.09 Fl.Bier	0.09	Flaschenteil 1× 0.09 Fl.Bier	0.09
1	0.09	1	0.09	1	0.09
0	0.00	0	0.00	0	0.00
Tomra 9 606657-90360001-61545-00 10:30 21-SEP-2022		Tomra 9 606657-90360001-61545-00 10:12 21-SEP-2022		Tomra 9 606657-90360001-67391-00 14:35 24-SEP-2022	

# Figure: Store II receipts for returned bottles.

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#### SBA Some Collected Receipts - (Store III) Research

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Motivation **RVM** Past Attacks Our Attack

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Bon 4279 Bon 4738 Bon 2602 Store Reaction 1x 0.09 FL.Bier 0.09 Flaschenteil Other countries 1× 0.09 Fl.Bier 0.09 0.09 1x 0.09 Fl.Bier 1 0.09 0.09 Tomra UNO Tomra UNO 606657-90155001-10452-00 606657-90155001-02049-00 0.00 16:26 23-SEP-2022 16:47 23-SEP-2022 Tomra 9

Figure: Store III receipts for returned bottles.

# **V**<sub>Research</sub> Comparison of multiple receipts

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- Store II Receipts all look the same, independent of timestamp, receipt no., location.
- Store I & III Receipts also look very similar, however, barcode seems to be somewhat dynamic.
- Receipts contain receipt no., maybe value of receipt is checked when used?

# SBA General RVM Receipts Structure / Content

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- Name of store (cut off)
- Address (cut off)
- Receipt Number (optional)

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- Credit
- Barcode
- Timestamp



# JAN-13 Barcodes

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- Barcode consists of 13 digits.
- Country Code (2 digits)
- Manufacturer Code (5 digits)

- Product Code (5 digits)
- Checksum (1 digit)

<b>SBA</b> Research	Supermarket Reaction/Response
ITSECX October 7th 2022 J. Zivanovic M. Leithner D. E. Simos Motivation RVM Functionality Past Attacks Our Attack Store Reaction	• 'We know'
Other countries Mitigation Conclusion	<ul> <li>'Who will exploit it?'</li> <li>'Known issue, will switch in future'</li> </ul>

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<b>SBA</b> Research	Related Work
ITSECX October 7th 2022	
J. Zivanovic M. Leithner D. E. Simos	
Motivation	
RVM Functionality	
Past Attacks	
Our Attack	$ullet$ A Security Analysis of the Danish Deposit Return System $^1$
Store Reaction	
Other countries	<ul> <li>Found same results for Danish stores</li> </ul>
Mitigation	
Conclusion	

# $\mathcal{V}_{\scriptscriptstyle \mathsf{Research}}^{\scriptscriptstyle \mathsf{SBA}}$ Lets look at another countries [Helsinki, Finland]

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- Almost every can/glass bottle/plastic bottle is recyclable
- Many RVMs in almost every supermarket
- Mostly same RVMs as in Vienna



Figure: Identical receipts for two separate bottle returns.

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# SBA Research Interesting Difference [Helsinki, Finland]

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- However, bottles from other countries sometimes have a special barcode sticker
- Potentially marker for machine to detect 'unusual' bottles that should be recycled
- What happens when the sticker is missing?
- What happens when the sticker is on another bottle?



Figure: 'Aftermarket' recycling sticker.

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# Research Another RVM Exploit [Helsinki, Finland]

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- 'Special Bottle' without sticker  $\implies$  No money, but still accepted (right)
- Normal Bottle (10c) with special sticker  $\implies$  20c receipt (left)
- Can we take any bottle and simply slap a sticker on it and get money?



Figure: Receipts of the modified bottles.



# Mitigation

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- Use dynamically generated codes
- Save unused codes in online database
- Remove code from database upon usage

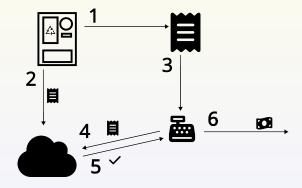


Figure: Possible mitigation against receipt forgery.

<b>SBA</b> Research	Conclusion
ITSECX October 7th 2022 J. Zivanovic M. Leithner D. E. Simos Motivation RVM Functionality Past Attacks Our Attack Store Reaction Other countries Mitigation Conclusion	<ul> <li>Just take the secure setup if you have the choice</li> <li>Don't use receipts (wasted paper)</li> </ul>

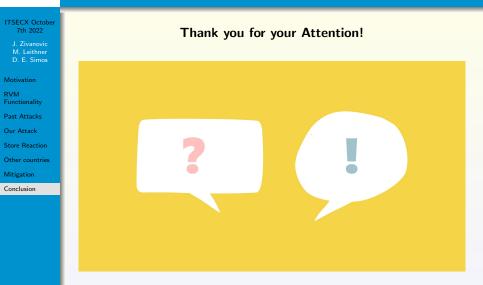
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Questions? - Comments?

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 [1] Austrian News Article referencing returnable plastic bottles and cans. Oesterreich.orf.at, 13.10.21 https://oesterreich.orf.at/stories/3125584/
 [2] Sueddeutsche Zeitung, Pfandbetrug 3 Fälle sueddeutsche.de, 13.10.21 https://www.sueddeutsche.de/panorama/

pfandbetrug-urteil-kriminalitaet-1.4403519

[3] Spiegel.de, Pfandautomat Manipulation Spiegel.de, 13.10.21 https://www.spiegel.de/panorama/justiz/ koeln-betrueger-erbeutet-mit-einer-pfandflasche-44-000 html

[4] Chip.de, Pfandbetrug *chip.de, 13.10.21* 

https:

//www.chip.de/news/Bei-Aldi-Lidl-Rewe-Edeka-und-Co.



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