BLUEBLEED Data Protection Impact Assessment

Google/Apple contact tracing side-channel attack on Bluetooth Smart Privacy

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Revision: 1.0 (2020-07-05) Initial draft

CVE-2020-13702
BLUEBLEED
ATTACK VECTOR: BLUETOOTH LE SMART PRIVACY
AFFECTED: ALL ANDROID/IOS DEVICES
WITH BLUETOOTH LE
CONTACT TRACING APPS
AFFECTED EU USERS: CA. 100M
11 GDPR COMPLAINTS PENDING
BOTH VENDORS STAKED IN PROXIMITY MARKETING
25BN ATTACK VEHICLES
*IOT 2020

Contents

Definitions

Bluetooth beacon	Low energy Bluetooth device with years of battery life running standards like Apple iBeacon
Bluetooth LE	Bluetooth Low Energy standard for low impact wireless communications up to 20m
Bluetooth LE Generic Attribute Profile (GATT)	Generic Attribute Profile is a listing of Bluetooth LE application data sets
Bluetooth Smart Privacy	Smart Privacy is a mechanism implemented to protect user location data for Bluetooth communications.
Contact tracing app	Mobile application that utilises Bluetooth LE to detect close proximity encounters
Contact tracing app publisher	Company/institution that publishes the app to the store (app developer)
Contact tracing Bluetooth framework publisher	Company publishing the Bluetooth framework and running the data processing infrastructure (Google/Apple in all examples in this analysis)
Data controller	Data controller is the entity defining and implementing the scope of data processing in GDPR (contact tracing app publisher)
Data processor	Data processor is an entity that follows data processing per instructions from outside (Google/Apple via Exposure Notification)
Data protection authority	Data protection authority is the supervisory body for the vulnerability at hand in their respective country
Data subject	Device holder who is subject to presented location tracking vulnerability
Exposure Notification	Google/Apple joint contact tracing framework effort
Internet of Things (IoT)	All devices connected to the internet
PEPP-PT/DP-3T	Generic Bluetooth LE based contact tracing architectures from which Exposure Notification derives

Foreword

In the research of the critical vulnerability at hand exposing potential hundreds of millions of app user locations the authors have communicated with Google, and to a lesser extent, with Apple to rectify the critical flaws in the Exposure Notification framework.

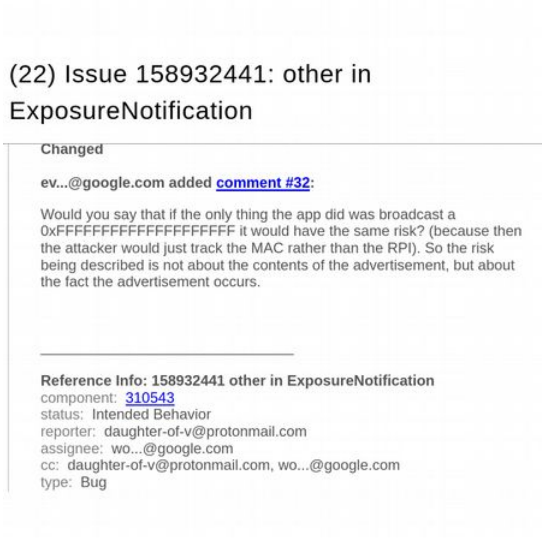
Namely CVE-2020-13702 *“Catastrophic breach of user privacy in Apple/Google COVID-19 Exposure Notification API”* [1] has unsuccessfully tried to deescalate the loss of user location protection for users of said contact tracing stack.

The Exposure Notification framework [2] is now live in multiple countries of the European Union since national contact tracing apps have been updated to use the new Google/Apple device independent tracking mechanism. Millions of active users are affected by the described vulnerability on launch.

PEPP-PT or DP-3T frameworks [3] are suffering from the same vulnerability and can also be considered affected by location privacy leakage, although a thorough analysis is outside of the scope of this paper.

Bluetooth LE Smart Privacy is a mechanism generally protecting users against such security exposures by protocol design. We will show that Google/Apple abuse the protocol mechanisms of Bluetooth LE beyond their original scope which results in the complete loss of Smart Privacy protection.

Lengthy discussions with the Google Security team about the issue scope have resulted in a standing `Intended Behavior` status for the ticket. Google does not approve of the definition of Exposure Notification being responsible for frequency and structure of messages sent as part of it's advertising scheme.



(22) Issue 158932441: other in ExposureNotification

Changed

ev...@google.com added comment #32:

Would you say that if the only thing the app did was broadcast a 0xFFFFFFFFFFFFFFFFFFFF it would have the same risk? (because then the attacker would just track the MAC rather than the RPI). So the risk being described is not about the contents of the advertisement, but about the fact the advertisement occurs.

Reference Info: 158932441 other in ExposureNotification
component: 310543
status: Intended Behavior
reporter: daughter-of-v@protonmail.com
assignee: wo...@google.com
cc: daughter-of-v@protonmail.com, wo...@google.com
type: Bug

Fig. 1: Google Security team on the scope of the vulnerability [4]

For the vendor the issue at hand is only related to a flaw in the current implementation, which is a defect that does not allow Android to rotate the RPI automatically together with driver layer issued MAC rotations. This is running in production of Exposure Notification and conflicts with the specification, but the effect to overall privacy leakage is minute.

Apple product security does not realise the implications of the side channel attack and the applicability to the IOS Exposure Notification implementation. The asynchronous communication channels with diverging points of view lead to believe that contrary to suggestion by the authors in the course of communication Google and Apple never corresponded with each other towards a solution of this issue.

The analysis at hand is the direct consequence of the vendor inaction. Due to the lack of cooperation on the matter the authors composed this analysis for a GDPR assessment as it should follow from the data protection authorities [5].

Analysis

Numerous national contact tracing app development initiatives have raised privacy concerns in regards to such technology. Data protection impact assessments [6] [7] have been executed against different mostly comparable situations with unclear results in either direction.

None of the existing privacy analysis have concerned themselves with a specific intricacy of the Exposure Notification/PEPP-PT/DP-3T approach which is the unconventional application of the Bluetooth LE protocol.

Existing Bluetooth LE applications do hold one of the following protocol usage patterns:

- Only process signals passively on the device
- Process signals actively on the device with paired communication peers

None of these applications hold the usage pattern of aforementioned contact tracing frameworks:

- Process signals actively on the device with broadcast advertising to everyone in signal range

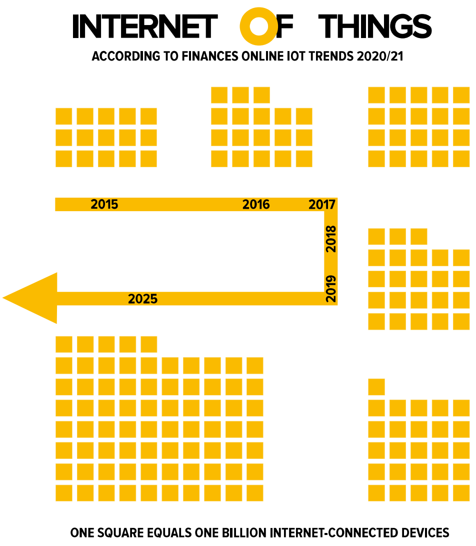
The basic premise of the pattern at hand is that there is a very frequent signalling mechanism (approx. 270ms recommended as per Google/Apple specifications). The second premise is that everyone within signal range can intercept and process the signal.

Now previous privacy assessments and Google/Apple's stance on the topic is that since they execute a stringent data encryption mechanism no user information is exposed in the protocol.

In this argument they ignore that both the metadata set of message occurrence in a high frequency domain as well as personally identifiable derivative identifiers included in the known encryption payload of Exposure Notification provide ample data for severe privacy violations.

A proposed location recovery mechanism is shown to simulate close to 100% of tracking accuracy over areas of devices covering Bluetooth LE. A concrete example of this vulnerability is presented in the domain of Bluetooth LE beacons as they are operated in fleets in urban and commercial areas for a variety of purposes.

Fig. 2: growth of internet-connected devices in the IoT until 2025, IOT Trends



Operators of beacon networks are therefor able to process Exposure Notification data without:

- User consent
- Lawful basis of processing
- Means to execute rights of the data holder

Looking at the growth rates of IoT devices it is easy to envision the real-world coverage of such devices in state-of-the-art commercial context.

Attack penetration groups of average capacity are likely able to penetrate the weak security defenses of such IoT fleets or do hold existing fleet capacity in botnets in the wild. Intelligence community access to such data sets seem granted.

The acceptance rate of apps based on vulnerable frameworks is expected to be very high due to general public awareness and semi-official sanctioning. Here is a (non-conclusive) list of current apps live and affected by the privacy leak:

Country	**App Name**	**Estimated audience***
Austria	Stopp Corona	6.4M
Czech Republic	eRouška	7.8M
Denmark	smitte|stop	4.2M
Finland	Ketju	4.0M
France	StopCovid	47.4M
Germany	Corona-Warn-App	59.9M
Hungary	VírusRadar	7.1M
Italy	Immuni	43.3M
Norway	Smittestop	3.9M
Poland	ProteGO Safe	27.9M
Spain	Radar COVID	33.8M
TOTAL		**245.7M**

*Table 1: List of Exposure Notification framework consumer apps or apps based on Google/Apple Exposure Notification. Data set enriched with potential user base for their respective EU member state. (*as of Statista 2019 EU-28 individuals using a mobile phone to access internet)*

The excerpt of EU countries participating in Bluetooth LE based contact tracing technology in the list above totals to 245.7M potential contact tracing devices, which would all be prone to the location data leakage described in this document.

With studies showing acceptance rates of around 50% for contact tracing technology in EU countries [8] a 2020 baseline estimate of mobile devices vulnerable to the privacy attack described in this analysis would be 100M+ affected devices in countries where GDPR privacy rules apply to contact tracing apps.

A mid-term scenario of hypothetical continued spread of COVID-19 disease pandemic and subsequent wave events forcing policy makers to increase counter measures might see global penetration of this contact tracing technology numbering in the Billions. The vast scope of the affected technology should highlight the special consideration required for the information leak vulnerability.

Bluetooth LE Smart Privacy

Quoting the Bluetooth SIG Blog entry “Bluetooth Technology Protecting Your Privacy” one might assume a stringent location sensitivity in involved applications: *“One privacy issue concerns the possibility of being tracked »where you go« in the physical world without your awareness or consent. »Where you go« could mean the places you drive or the route you walk.”* [9]

Bluetooth LE Smart Privacy is a technology that is designed to protect the Bluetooth LE use cases from illicit listen-in perpetrators. Bluetooth LE Generic Attribute Profile (GATT) enumerates the design use cases for the protocol. Contrary to contact tracing frameworks like PEPP-PT, DP-3T or implementations like Google/Apple Exposure Notification traditional applications for Bluetooth LE on mobile devices are of less noisy signalling patterns:

- Passive signal processing occurs on mobile devices, data sent via nearby beacons on public channel is received
- Active signal processing occurs on mobile device with peer device like smart watch, data sent between peered devices via encrypted private channel

Contact tracing reverts the beacon situation for mobile devices:

- Active signal processing occurs on mobile device via public channel, metadata and dual rotation identifier leaks too much personally identifiable information due to high advertising frequency

This leads to a broken Smart Privacy implementation in the design of Exposure Notification and similar technologies. Google has had difficulty to differentiate the private implementation defects in their Exposure Notification from core protocol deficiencies. Non-the-less the privacy laws guarantee app users basic rights to their data not met as per the current specification and mode of operation for live apps.

The details of loss of Smart Privacy will follow in course of the data processing analysis.

Legal personas

It is important to characterise the different legal entities involved in the data processing to be able to assess the vulnerable components and the subsequent abuse potential.

For the sake of this document the legal personas involved in the offending processing case are listed within this chapter in a form compatible with GDPR. Similar roles might apply to different legal settings.

Country	App Name	App Publisher = GDPR data controller
Austria	Stopp Corona	Austrian Red Cross
Czech Republic	eRouška	Ministerstvo zdravotnictví České republiky
Denmark	smitte|stop	Sundheds- og Ældreministeriet
Finland	Ketju	Reaktor
France	StopCovid	Gouvernment
Germany	Corona-Warn-App	Robert Koch Institut
Hungary	VírusRadar	Kormányzati Informatikai Fejlesztési Ügynökség
Italy	Immuni	Ministero della Salute
Norway	Smittestop	Folkehelseinstituttet
Poland	ProteGO Safe	Ministerstwo Cyfryzacji
Spain	Radar COVID	Ministerio de Asuntos Económicos y Transf. Digital

Table 2: list of GDPR data controllers for published Exposure Notification apps

In addition to the data controller role both the device manufacturers and Google/Apple providing the application and operating system layer are involved in the data processing scheme:

Country	Company	GDPR data processor type
South Korea	Samsung	Device/driver manufacturer
USA	Apple	Device/driver manufacturer
China	Huawei	Device/driver manufacturer
China	Xiaomi	Device/driver manufacturer
China	Oppo	Device/driver manufacturer
South Korea	LG	Device/driver manufacturer
USA	**Apple**	**Operating system manufacturer (iOS)**
USA	**Google**	**Operating system manufacturer (Android)**
Unkown	**Unknown**	**Bluetooth beacon fleet operators**

Table 3: List of data processors due to technical involvement in Bluetooth LE feature delivery

Due to the leakage of personal information into the public Bluetooth protocol layer every operator of Bluetooth equipped hardware is a potential data processor.

In the light of this analysis traditional advertising companies operating physical Bluetooth LE beacon fleets in urban areas are considered the example candidate for exploitation. The beacon infrastructure is abused by retrofitting device location and movement data from beacon log data including the contact tracing Bluetooth LE advertising handshakes.

Here is an example of beacon operational data from beaconstac, one of the leading SMB type proximity marketing companies:

Countries operated in	40+
Small businesses using	10,000+
Resellers and data sub-processors	**100+**
Proximity notifications delivered	3M+

Table 4: beaconstac usage statistics (end of June 2020), incl. reference to potential sub-processing of data events

As soon as the beacons deployed by this company register and log contact tracing events they are considered a data processor for the person holding the device issuing the events. Neither consensual nor implicit relationship with legal grounds for data processing between device holder and Bluetooth beacon operators are provided for.

Since many of these companies are involved with digital marketing demand-side platforms (DSPs) there is a high number of further unspecified data sub-processors to be expected in the pipeline of this location tracking data stream [10].

Offending data processing cases

This document will not get into detail about previously documented and independently assessed data processing cases but for the sake of demonstrating the protocol deviation of Exposure Notification and other Bluetooth LE application profiles.

Note that the scope restriction also excludes non-Bluetooth related components of Exposure Notification and similar contact tracing frameworks like PEPP-PT or different DP-3T variants.

Encryption in the frameworks is not considered in more detail than necessary in this analysis because the message structure/frequency and simple metadata is sufficient to attack user privacy. An encryption protocol weakness could weaken the privacy integrity even further but for this analysis we investigate with the basic premise of a sound protocol layer security implementation.

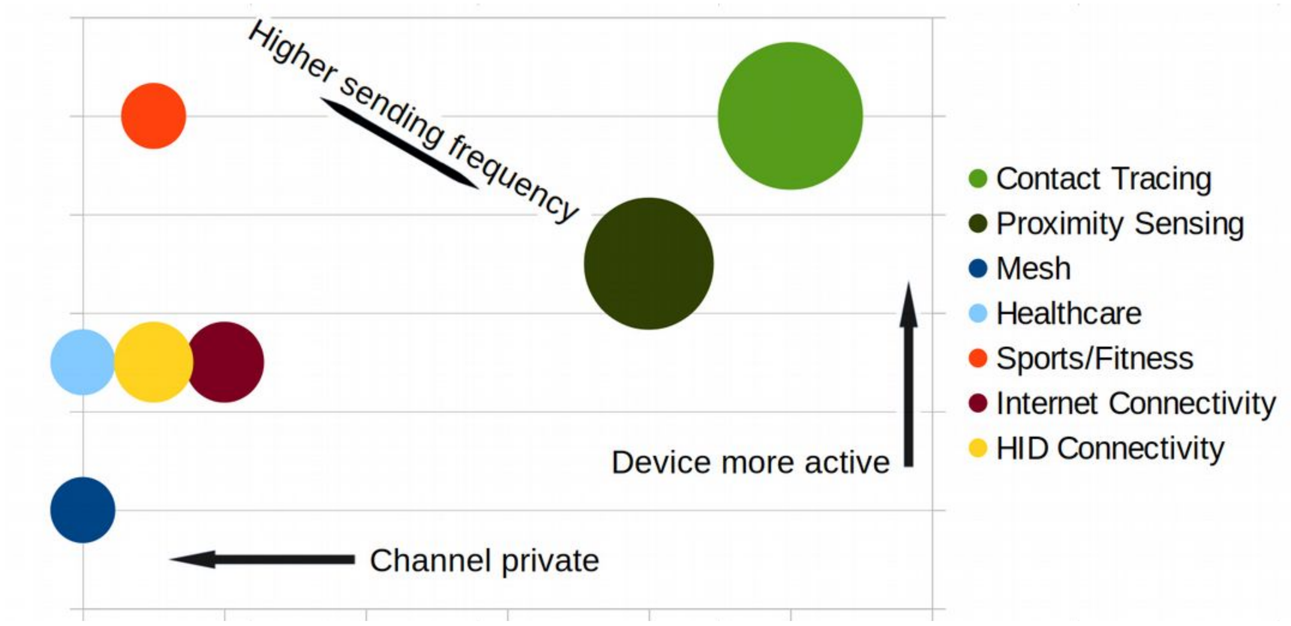


Fig. 3: Bluetooth LE Generic Attribute Profile (GATT) compared by channel privacy, user device activity and sending frequency

As can be seen on the GATT chart Bluetooth LE applications that are part of the stable protocol specifications use a very different signalling pattern compared to Exposure Notification and similar contact tracing frameworks.

While traditional applications are usually in paired mode or in public channels where passive user devices keep a very low profile. Contrary to that mode of operations the Contact Tracing application pattern demands that a user device constantly advertises itself to all listeners in range, up to multiple times per second.

This should intuitively highlight the compatibility issue of Exposure Notification with Bluetooth LE, and specifically Smart Privacy protection mechanisms in place.

Concrete examples of established applications applying Bluetooth LE fundamentally differently are:

Smart watch	Communicates every n minutes on avg.	With a paired peer via encrypted channel but mobile device is only passive in this secure communication path
Retail proximity marketing beacon	Communicates every n seconds on avg.	On public channel but mobile device is only passive in this communication path
Audio	Communicates constantly	With a paired peer via encrypted channel
Exposure Notification	**Communicates constantly**	**On public channel**

Table 5: Bluetooth LE application examples describing communication patterns

The following figure illustrates the signalling behaviour of consumer apps using Exposure Notification or a similar framework. According to the specification [2] each device sends out a signal via Bluetooth LE advertising approx. every 300ms. Neighbouring devices activate their Bluetooth scanning mechanism to receive advertises as they are transmitted roughly every five minutes. Sniffers can permanently scan to ingest signals into logs for post-processing every 300ms-3s.

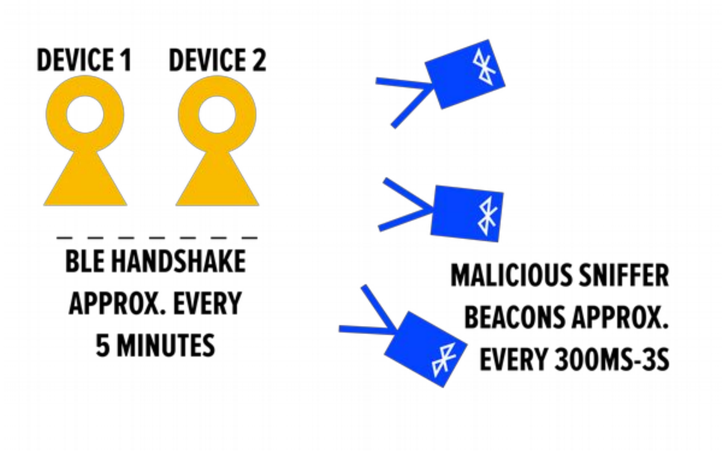

DEVICE 1
DEVICE 2
BLE HANDSHAKE APPROX. EVERY 5 MINUTES
MALICIOUS SNIFFER BEACONS APPROX. EVERY 300MS-3S

Fig. 4: regular handshake interval vs. malicious sniffer signalling activity

Exposure Notification introduces a distinct UID, which is encrypted and as such a pseudonymous identifier for the user device. Bluetooth Smart Privacy uses a MAC address scheme rotation that introduces a pseudo-random identifier per user. Both should see a rotation around every 15 minutes to reset the device privacy and deny following signals.

As the figure below shows the dual identifier situation introduces a trace pattern for Smart Privacy protected devices not present without Exposure Notification. This vulnerability exposes device location data for every signal receiver in range.

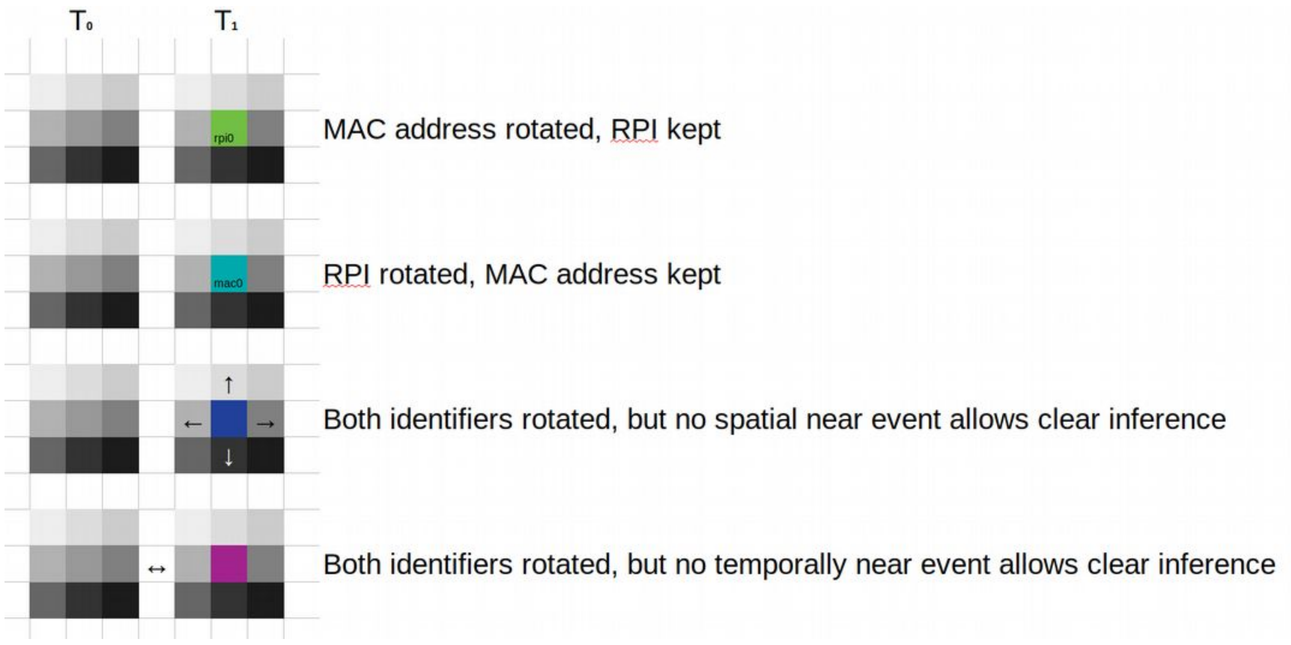

T₀
T₁
rpi0
MAC address rotated, RPI kept
mac0
RPI rotated, MAC address kept
↑
←
→
↓
Both identifiers rotated, but no spatial near event allows clear inference
↔
Both identifiers rotated, but no temporally near event allows clear inference

Fig. 5: four trackable rotation scenarios in a cluster of 9 devices showing vulnerable side channels for unique device identification

Agent-based simulations [11] for the exploit reported in CVE-2020-13702 show an extremely high tracking hit rate which is attainable with an efficient location resolver that handles spatial and temporal event data as well as the dual identifier rotation.

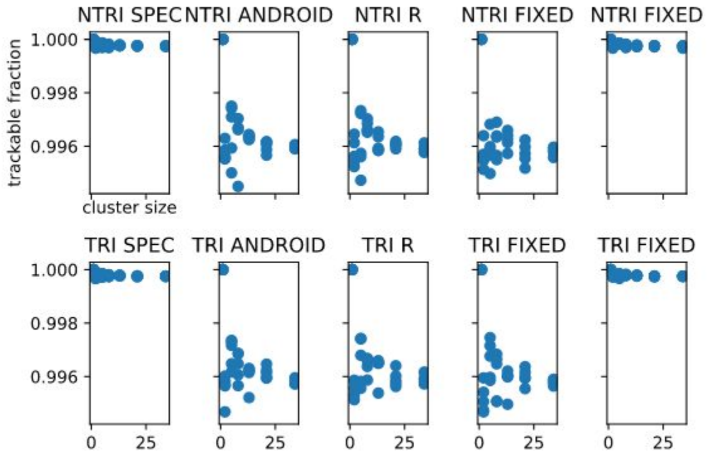


Fig. 6: regardless of timer setup and/or implementation quality the traceability is close to 100% due to the loss of Bluetooth Smart Privacy

Bluetooth beacon vulnerabilities

As explained there is no legitimate basis for data processing of Exposure Notification signals in the ubiquitous beacon fleets. An additional factor for the analysis poses the fact that the IoT is accompanied by low security expectations.

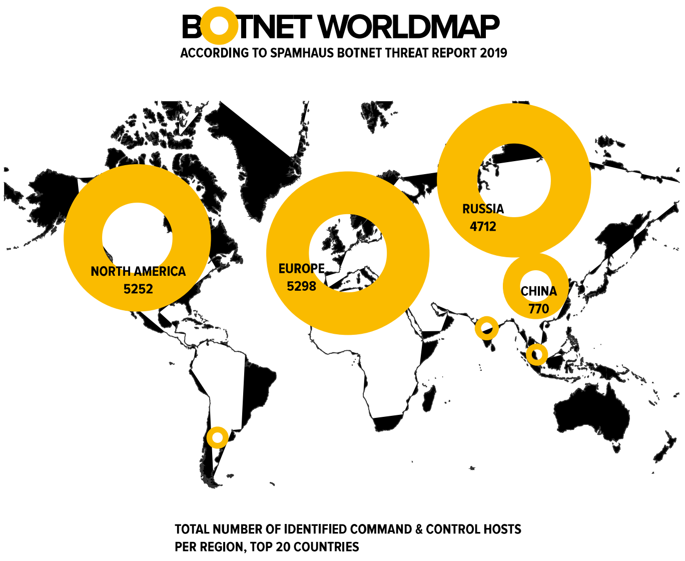

BOTNET WORLDMAP
ACCORDING TO SPAMHAUS BOTNET THREAT REPORT 2019
NORTH AMERICA
5252
EUROPE
5298
RUSSIA
4712
CHINA
770
TOTAL NUMBER OF IDENTIFIED COMMAND & CONTROL HOSTS
PER REGION, TOP 20 COUNTRIES

Fig. 7: botnet command&control distribution 2019, Spamhaus

Numerous vulnerabilities in beacon enabled devices imply constant attack on this infrastructure, as the following correlation with OWASP Top 10 IoT security issues highlights [12].

A historic example of the vulnerability of Bluetooth LE in the IoT is the “Bleeding Bit” attack of 2018 [13]. Numerous items in the OWASP hit list create a specifically challenging security environment for IoT applications.

Rank	Vulnerability
1	Weak, guessable or hard coded passwords
2	Insecure network services
3	Insecure ecosystem interfaces
4	Lack of secure update mechanism
5	Use of insecure or outdated components
6	Insufficient privacy protection
7	Insecure data transfer and storage
8	Lack of device management
9	Insecure default settings
10	Lack of physical hardening

Table 6: OWASP Top 10 Internet of Things 2018 as applicable to Bluetooth LE beacons

With incentives for targeted measures it is likely that advanced penetration actors like nation state backed groups will have or do already have the control of large international device coverage.

Loss of data subject rights

This analysis will focus on the implications that sniffing Bluetooth beacons are creating in regards to data protection rules applicable to contact tracing apps breaking Bluetooth Smart Privacy. The parameters of primary contact tracing functionality incl. necessary data encryption schemes have already discussed a priori and are not in scope of/to be criticised in this document.

Below is a list of articles offended by the Exposure Notification vulnerability incl. rationale for the decision [14]:

Lawfulness of processing; Art. 6: Bluetooth beacons are not able to lawfully process device location data and thus Exposure Notification users should be protected in a form similar to non-users via Bluetooth Smart Privacy. There is no consent mechanism since the passing of beacon networks is randomly occurring while travelling geographically and an explicit handshake does not exist for public advertising protocols like Exposure Notification.

Conditions for consent; Art. 7: There is consent established for the relationship between Exposure Notification users and beacon fleet operators.

Transparent information, communication and modalities for the exercise of the rights of the data subject; Art. 12: The existence of Bluetooth LE beacons in public spaces and the non-optional consent are not communicated in any way through the contact tracing app on-boarding or run-time interface.

Information to be provided where personal data are collected from the data subject; Art. 13: The existence of Bluetooth LE beacons in public spaces and the non-optional consent for data collection are not communicated in any way through the contact tracing app on-boarding or run-time interface.

Data subject rights; Art. 15-21: The Bluetooth LE beacon networks are comprised of hidden devices and it is difficult to find out network operators behind physical locations. There is no way to execute these rights as a data subject.

Data protection by design and by default; Art. 25: Due to breaking of Smart Privacy the Exposure Notification protocol does not offer data protection by design and default any longer.

Representatives of controllers or processors not established in the Union; Art. 27: Large advertising outlets and retail companies operate internationally, so European Union processing is not guaranteed.

Processor; Art. 28, 30: There is no established data processing role for Bluetooth LE beacons currently, which renders the mentioned processing requirements unattainable.

Vulnerability benefactors

Due to the complex interaction of Bluetooth LE Smart Privacy and Exposure Notification protocol design the demonstrated vulnerability has not been captured in preceding security or privacy assessments.

As a side channel attack it is an obscure vector that is difficult to spot and align with the attack goals.

Non-the-less the situation demands the question if this is a well hidden surveillance package deployed in an opportune situation.

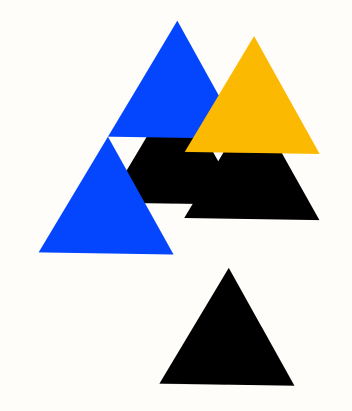
Independent of the facts surrounding this context the following benefactors can be identified in regards to the loss of Bluetooth Smart Privacy and/or tracking protection:

Google: as the largest advertising company in the world physical advertising space targeting is on the to-do list. Beacon fleet operators for physical advertising space or proximity marketing are some of Google’s largest partners [15].

Apple: as the innovator and leader in proximity apps and business leverage behind such applications the increased acceptance of such technology is a bonus for the iBeacon company [16].

Advertising industry: existing physical advertising targeting and viewer statistics will be able to leverage improved (movement) data sets [17].

Surveillance/intel community: the privacy leak enables the tracking of individuals throughout areas covered by accessible Bluetooth LE beacons. It is useful in the augmentation of other tracking technologies like face detection for crowded areas or regions without suitable visual coverage.



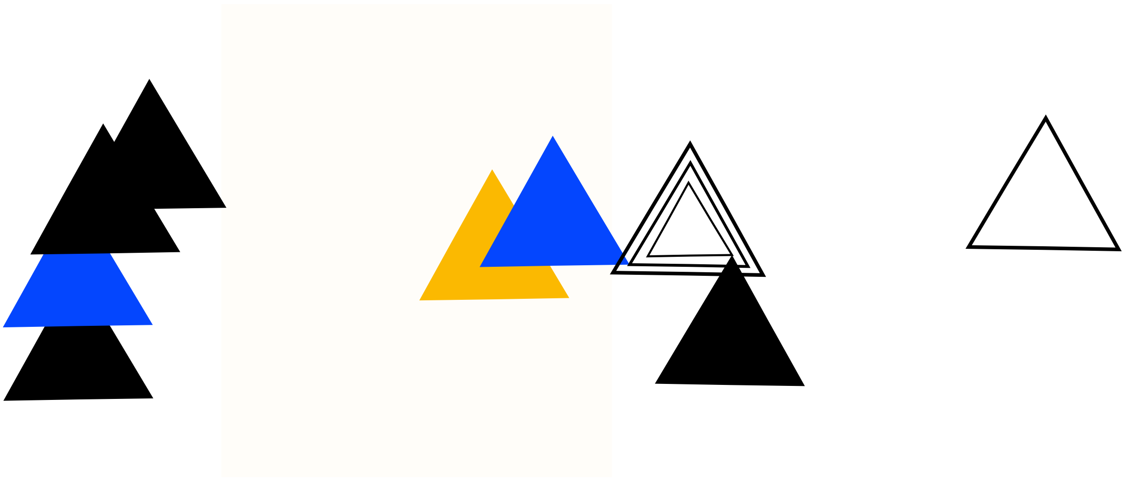
Conclusion

The GDPR impact of the identified side channel attack on location data is large in multiple dimensions:

- Over **250M potential affected users**. 100M upwards seem realistic for the course of 2020
- Attack vector is Bluetooth LE broadcast scanning which is completely passive, so there is **no way for the user to opt out** of this communication
- Simulations of distinct or densely clustered mobile device groups have shown **close to 100% traceability success rate**
- There is **no legal grounds for the data processing capabilities** of Bluetooth beacon operators and the leaked location data
- Operators of Bluetooth beacon fleets are often involved in digital marketing demand-side platforms (DSPs) with active data exchange with a **large number of further unspecified data sub processors**
- Non opt-out location data tracking is **politically and economically consequential**

There is no doubt that the legal grounds for processing this kind of high frequency beacon signal data are not provided for within Exposure Notification.

Both the contact tracing app publishers (data controllers) and Google/Apple as vendor for the Exposure Notification framework (data processors) need to consider to shut off the affected infrastructure until the data protection impact assessment items have been accounted for in a revised protocol design.



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Appendix I – data protection authorities

The tables below lists the data protection authorities supervising the respective contact tracing app vendor. As such both are responsible to take action to protect user privacy rights damaged by Exposure Notification.

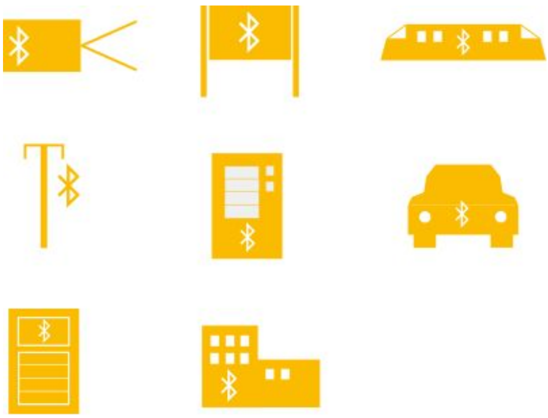
Country	App Name	GDPR data protection authority
Austria	Stopp Corona	**Österreichische Datenschutzbehörde** Hohenstaufengasse 3 1010 Wien Tel. +43 1 531 15 202525 Fax +43 1 531 15 202690 e-mail: dsb@dsb.gv.at Website: http://www.dsb.gv.at/
Czech Republic	eRouška	**The Office for Personal Data Protection** Urad pro ochranu osobnich udaju Pplk. Sochora 27 170 00 Prague 7 Tel. +420 234 665 111 Fax +420 234 665 444 e-mail: posta@uoou.cz Website: http://www.uoou.cz/
Denmark	smitte|stop	**Datatilsynet** Borgergade 28, 5 1300 Copenhagen K Tel. +45 33 1932 00 Fax +45 33 19 32 18 e-mail: dt@datatilsynet.dk Website: http://www.datatilsynet.dk/
Finland	Ketju	**Office of the Data Protection Ombudsman** Ratapihantie 9 FIN-00520 Helsinki Switchboard: +358 (0)29 566 6700 Registry: +358 (0)29 566 6768 e-mail: tietosuoja@om.fi Website: http://www.tietosuoja.fi/en/
France	StopCovid	**Commission Nationale de l'Informatique et des Libertés - CNIL** 8 rue Vivienne, CS 30223 F-75002 Paris, Cedex 02 Tel. +33 1 53 73 22 22 Fax +33 1 53 73 22 00 Website: http://www.cnil.fr/
Germany	Corona-Warn-App	**Die Bundesbeauftragte für den Datenschutz und die Informationsfreiheit** Husarenstraße 30

		53117 Bonn Tel. +49 228 997799 0; +49 228 81995 0 Fax +49 228 997799 550; +49 228 81995 550 e-mail: poststelle@bfdi.bund.de Website: http://www.bfdi.bund.de/
Hungary	VírusRadar	**Data Protection Commissioner of Hungary** Szilágyi Erzsébet fasor 22/C H-1125 Budapest Tel. +36 1 3911 400 e-mail: peterfalvi.attila@naih.hu Website: http://www.naih.hu/
Italy	Immuni	**Garante per la protezione dei dati personali** Piazza di Monte Citorio, 121 00186 Roma Tel. +39 06 69677 1 Fax +39 06 69677 785 e-mail: garante@garanteprivacy.it Website: http://www.garanteprivacy.it/
Norway	Smittestop	**Datatilsynet** P.O. Box 458 Sentrum NO-0105 Oslo Tel + 22 39 69 64
Poland	ProteGO Safe	**The Bureau of the Inspector General for the Protection of Personal Data - GIODO** ul. Stawki 2 00-193 Warsaw Tel. +48 22 53 10 440 Fax +48 22 53 10 441 e-mail: kancelaria@giodo.gov.pl; desiwm@giodo.gov.pl Website: http://www.giodo.gov.pl/
Spain	Radar COVID	**Agencia de Protección de Datos** C/Jorge Juan, 6 28001 Madrid Tel. +34 91399 6200 Fax +34 91455 5699 e-mail: internacional@agpd.es Website: https://www.agpd.es/
EU	-	**European Data Protection Supervisor** Rue Wiertz 60 1047 Bruxelles/Brussel Office: Rue Montoyer 63, 6th floor Tel. +32 2 283 19 00 Fax +32 2 283 19 50 e-mail: edps@edps.europa.eu Website: http://www.edps.europa.eu/EDPSWEB/

Table 7: list of GDPR data authorities responsible for published Exposure Notification apps

Country	App Name	App Vendor
Austria	Stopp Corona	**Österreichisches Rotes Kreuz** e-mail: thomas.marecek@roteskreuz.at Website: https://www.roteskreuz.at/
Czech Republic	eRouška	**Ministerstvo zdravotnictví České republiky** e-mail: verejnost@mzcr.cz Website: http://www.mzcr.cz/
Denmark	smitte|stop	**Sundheds- og Ældreministeriet** e-mail: sum@sum.dk Website: https://sum.dk/
Finland	Ketju	**Futurize** e-mail: michael.samarin@futurice.com Website: https://futurice.com/ **Reaktor** Tel. +358 (0)9 4152 0200 Website: https://www.reaktor.com/
France	StopCovid	**Commission Nationale de l'Informatique et des Libertés - CNIL** Tel. +33 1 53 73 22 22 Website: http://www.cnil.fr/
Germany	Corona-Warn-App	**Robert Koch Institut** Website/Contact: https://www.rki.de/EN/Service/Contact/Contact_node.html
Hungary	VírusRadar	**Kormányzati Informatikai Fejlesztési Ügynökség** e-mail: ugyfelszolgalat@kifu.hu Website: https://kifu.gov.hu/
Italy	Immuni	**Ministero della Salute** Tel. +39 06 59941 Website: http://www.salute.gov.it/
Norway	Smittestop	**Folkehelseinstituttet** e-mail: Folkehelseinstituttet@fhi.no Website: https://www.fhi.no/
Poland	ProteGO Safe	**Ministerstwo Cyfryzacji** e-mail: mc@mc.gov.pl Website: https://www.gov.pl/web/cyfryzacja
Spain	Radar COVID	**Ministerio de Asuntos Económicos y Transf. Digital** Tel. +34 91 258 28 52 Website: https://www.mineco.gob.es

Table 8: list of contact tracing app vendors responsible for published Exposure Notification apps



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... AND AS VERCINGETORIX WAS OVERRUN BY ROMAN SOLDIERS, WITH HIS DYING WORDS HE DEMANDED HIS HAMMER BROUGHT TO HIS DAUGHTER
FOR THE STORY OF VERCINGETORIX HAS JUST BEGUN ...