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National Research Centre on Privacy, Harm Reduction and Adversarial Influence Online

REPHRAIN
Protecting citizens online

REPHRAIN Privacy Testbed

Partha Das Chowdhury. (partha.daschowdhury@bristol.ac.uk)
Joe Gardiner (joe.gardiner@bristol.ac.uk)

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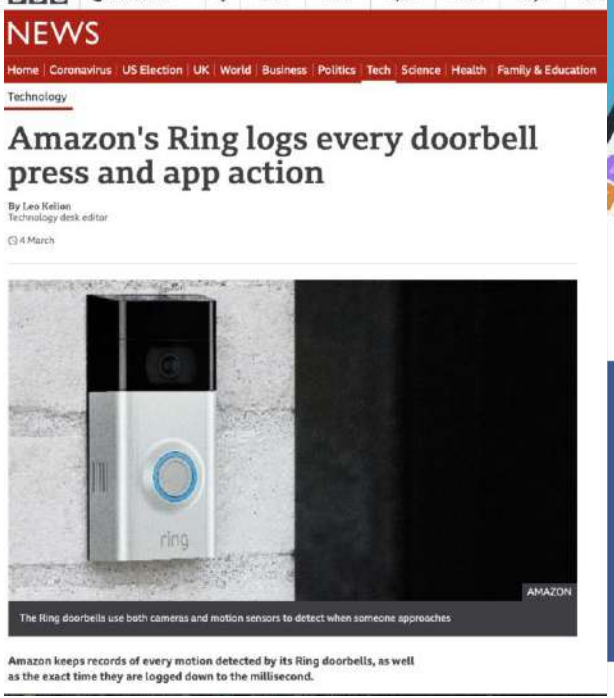
Why a Privacy Testbed?



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Why a Privacy Testbed?

App Developer

Assurance about privacy properties – regulatory compliance, care for users, behaviour of third-party libraries/APIs

Regulators

Checking claims about data and information storage and flows for compliance

Researchers/Journalists/ Citizens Rights Groups

Rigorous evaluation under experimental conditions; generating and sharing datasets.

End users

Does it do what it says on the tin? (a.k.a privacy policy, DPIA or privacy labels).

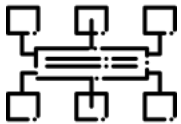
Implementation

Virtualisation

- Can deploy OS from disk image, or build as required
- Android applications emulated using Google's Android Virtual Device (AVD)
  - Deployed inside Ubuntu Desktop VM
- Virtualisation managed by kvm-compose tool

Kvm-compose

- CLI tool built by the team for Linux using RUST (and the libvirt library)
- Create custom test environments from configuration file using (up/down commands)

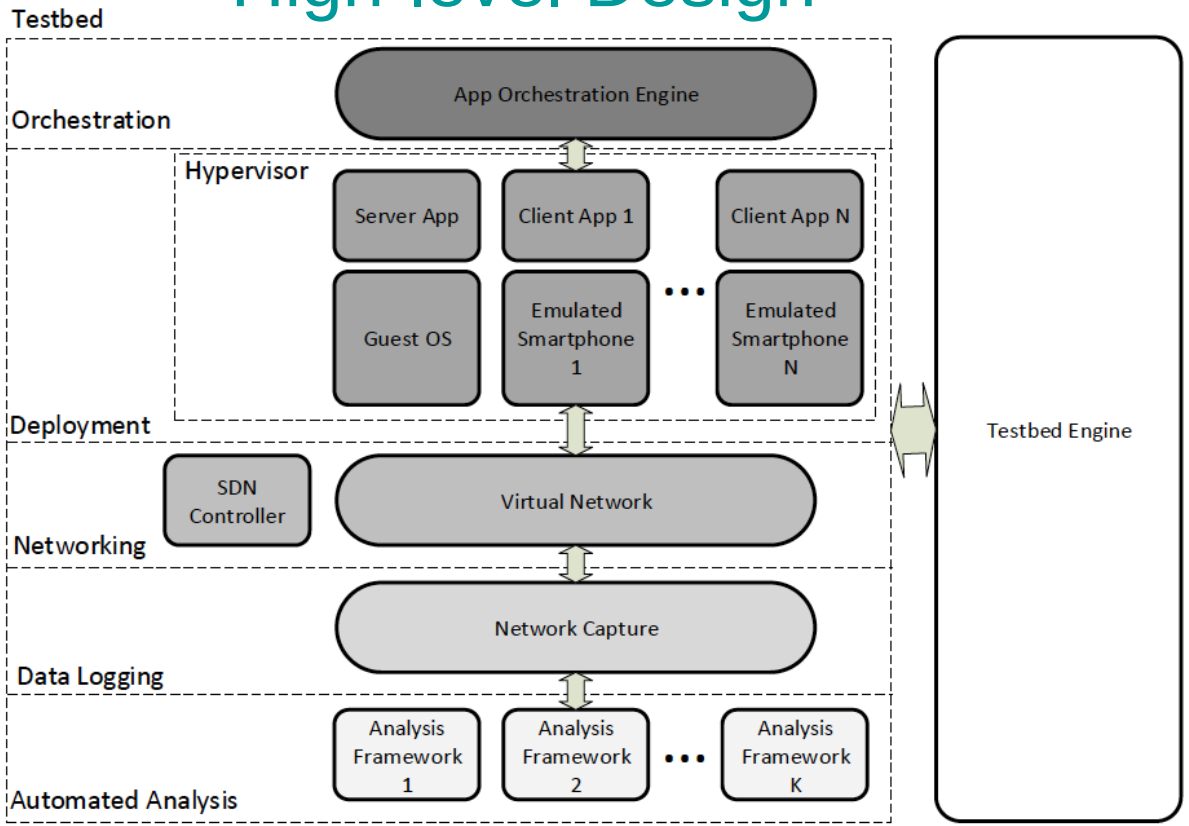


Networking

- Networking is provided using OpenvSwitch (OVS)
- OVS bridges can easily be linked up to an SDN controller (such as Floodlight), enabling more advanced network management.

High-level Design

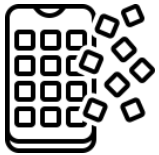
kvm-compose



Challenges and Lessons

Cloud Lock-in

The level of abstraction, we model the protocols/applications



App Interaction

Not a case of plug n play. E2EE apps require a SIM
Need for custom scripts to simulate user interaction in ADB.

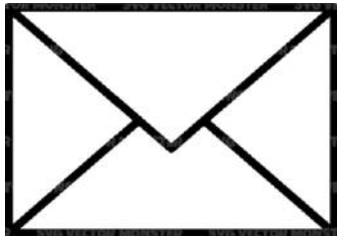
Testbed Implementation

Validate state transitions while configuring playbooks.

Signal Desktop client on the Testbed
(University of Bristol & University of Cambridge)

Pixel 3 with Android 10 Q (API 29)

Standard Signal Desktop



TLS-Interceptor

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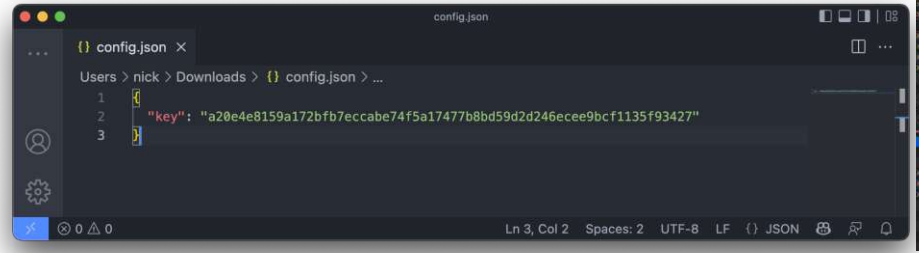
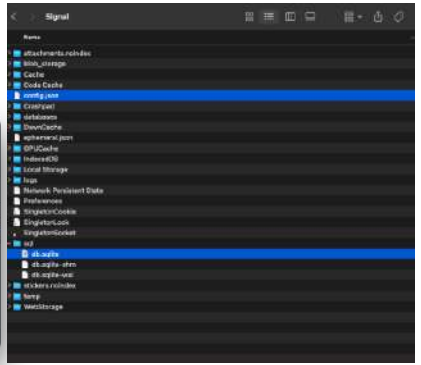
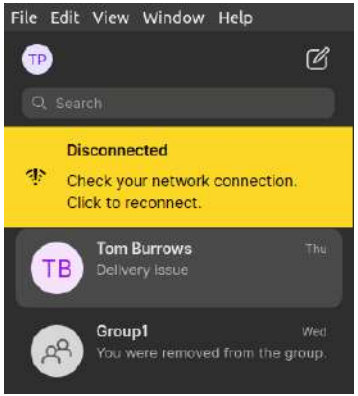
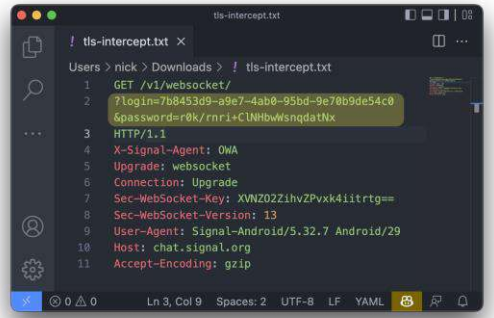
Plaintext Key







Short Lived Adversarial Access



Victim Desktop Warning

TLS-Interceptor

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ments	hasVisualMediaAttachments	expireTimer	expirationStartTimestamp	type	body	messageTimer	messageTimerStart	messageTimerExpiresAt	isErased	isViewOnce	sourceUuid	
	Filter	Filter	Filter	Filter	Filter	Filter	Filter	Filter	Filter	Filter	Filter	Filte
0	0	NULL	NULL	story	NULL	NULL	NULL	NULL	0	0	11111111-1111-4111-8111-111111111111	NU
0	0	NULL	NULL	story	NULL	NULL	NULL	NULL	0	0	11111111-1111-4111-8111-111111111111	NU
0	0	NULL	NULL	story	NULL	NULL	NULL	NULL	0	0	11111111-1111-4111-8111-111111111111	NU
0	0	NULL	NULL	story	NULL	NULL	NULL	NULL	0	0	11111111-1111-4111-8111-111111111111	NU
0	0	NULL	NULL	story	NULL	NULL	NULL	NULL	0	0	11111111-1111-4111-8111-111111111111	NU
0	0	NULL	1674037405226	outgoing	Hello!	NULL	NULL	NULL	0	0	NULL	NU
0	0	NULL	NULL	incoming	Hi	NULL	NULL	NULL	0	0	e54b8b4b-[redacted]	92c

	active_at	type	members	name	profileName	profileFamilyName	profileFullName	e164	uuid	groupId	profileLastFetchedAt
	Filter	Filter	Filter	Filter	Filter	Filter	Filter	Filter	Filter	Filter	Filter
ageCount":...	1674037744693	private	NULL	NULL	Riders Pride	NULL	Riders Pride	+9198[redacted]	e54b8b4b-[redacted]	NULL	1674037744800
sageCount":...	1674037405067	private	NULL	Partha Das Chowdhury	NULL	NULL	NULL	+4474[redacted]	b661ee80-[redacted]	NULL	1674037702332
sageCount":...	NULL	private	NULL	NULL	Jgardiner	NULL	Jgardiner	+4479[redacted]	0f5d0097-[redacted]	NULL	1674037372334

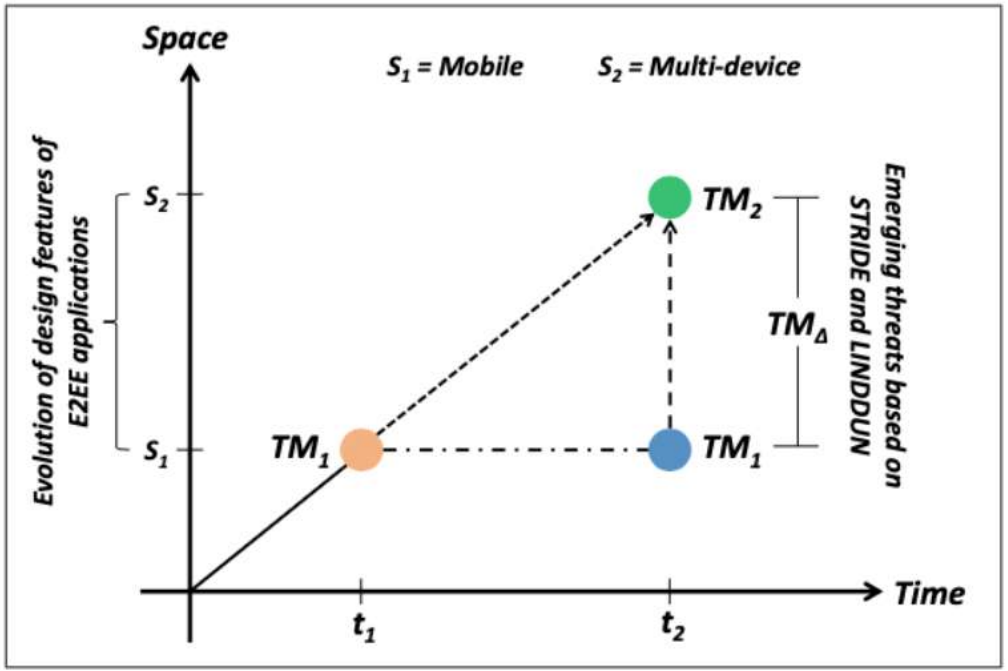
Short Lived Adversarial Access

Threat Models over Space and Time: A Case Study of E2EE Messaging Applications

Partha Das Chowdhury*, Maria Sameen*, Jenny Blessing†, Nicholas Boucher†, Joseph Gardiner*, Tom Burrows†, Ross Anderson†‡, Awais Rashid*
*University of Bristol, UK {partha.daschowdhury, maria.sameen, joe.gardiner, awais.rashid}@bristol.ac.uk
†University of Cambridge, UK. {jenny.blessing, nicholas.boucher, ross.anderson}@cl.cam.ac.uk, tom@tpmb.uk
‡University of Edinburgh, UK ross.j.anderson@ed.ac.uk

http://arxiv.org/abs/2301.05653

Motivation



Evolution of Threat Models – Short lived (adversarial) access

Short Lived Adversarial Access

Applications	Emerging Threats (TM_{Δ})												
	S	*T*	*R*	*I*	*D*	*E*	*L*	*I*	*N*	*D*	*D*	*U*	*N*
Signal	✓	-	✓	✓	×	✓	✓	✓	✓	-	✓	-	-
Whatsapp	✓	-	✓	✓	×	×	✓	✓	✓	-	✓	-	-
Element	×	-	×	✓	×	×	✓	×	×	-	✓	-	-
Wickr Me	×	-	×	×	×	×	×	×	×	-	×	-	-
Viber	×	-	×	×	×	×	×	×	×	-	×	-	-
Telegram	✓	-	✓	✓	×	×	✓	✓	✓	-	✓	-	-

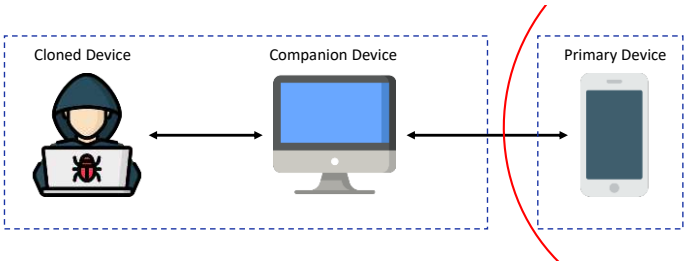
(-) -> Not tested, (x) -> Attack not possible, (✓) -> Attack possible

STRIDE:
- Spoofing
- Tampering
- Repudiation
- Information disclosure
- Denial of service (DoS)
- Elevation of privilege

LINDDUN:
- Linkability
- Identifiability
- Non-Repudiation
- Detectability
- Disclosure of Information
- Unawareness
- Non-compliance

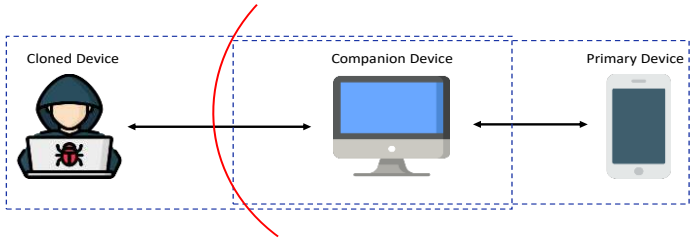
Aligning Administrative boundary & Trust Boundary

- Administrative boundary – Logical entities within which we function
- Trust boundary –The placement of security controls

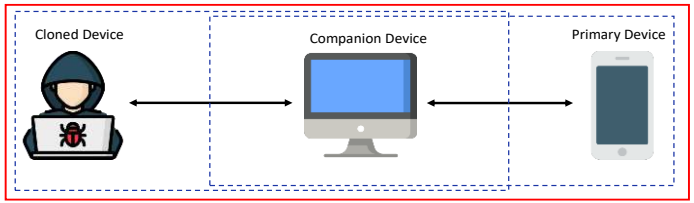


- Trust boundary includes only the device.
- Requires frequent access control even for short lived access.

Aligning Administrative boundary & Trust Boundary



- Anyone within the administrative boundary can clone desktop clients through short lived access.
- The trust boundary includes legitimate insiders who can turn malicious



- Desktop clients cannot be cloned through short lived access.
- Trust boundary incudes only desktop clients fired by the primary device.

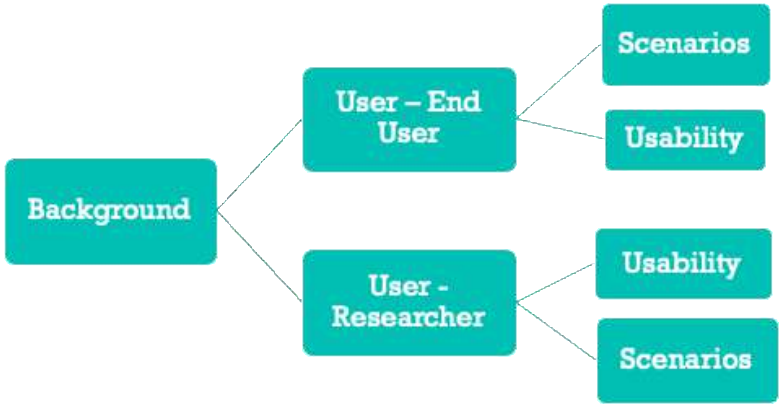
Security Engineering Lessons

- Reconciliation of security requirements across components with shared state
  - Desktop clients and primary devices share state.
  - Shared state is open to compromise in some desktop clients.
  - Model the threats of the shared components.

- Safe Defaults
  - Participants behavior change over time.
  - Threat modelling should accommodate this change in behavior and intentions.

Ongoing and Future Plans

Ongoing – Focus Groups with Wider Testbed Users



Future Implementation Priorities

- Scale up in terms of deployment of VMs
- Connecting with other test beds (e.g., IoT/LoraWAN at Edinburgh)
- Usability to the extent possible without oversimplifying the testbed.
- Integrate additional (external) analysis tools in the Testbed
- Enable the community to have a commodity privacy testbed.

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To learn more about REPHRAIN, our future plans and how to get involved:

www.rephrain.ac.uk

@REPHRAIN1

rephrain-centre@bristol.ac.uk

We would love to hear from you. Thank you!

E2EE Paper: http://arxiv.org/abs/2301.05653

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