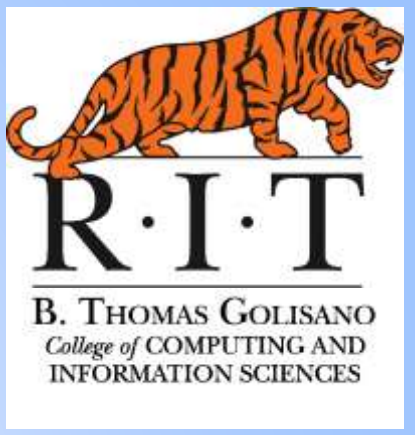

What is Android Colluded Applications Attack and How to Detect It?

Igor Khokhlov, Leon Reznik

ixk8996@rit.edu, lr@cs.rit.edu

Rochester Institute of Technology

Rochester, NY

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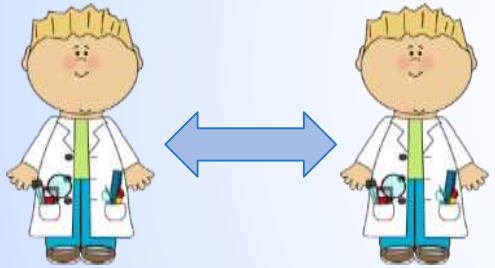
Content

- Data Quality and Security in real life
- Android security mechanisms
- Overt communication channel
  - Overview
  - Attack scenario
  - Attack analysis
- Covert communication channel
  - Overview
  - Attack scenario
  - Attack analysis
- Colluded application attack detection
- Conclusion

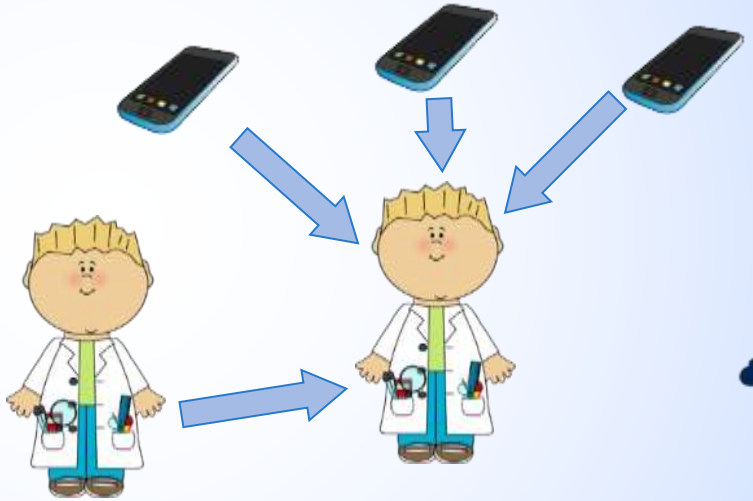
Data Quality

Old data collection model



From a scientist to a scientist

Modern data collection model



Citizen science

Internet of Things

Quality Data

What is data quality?

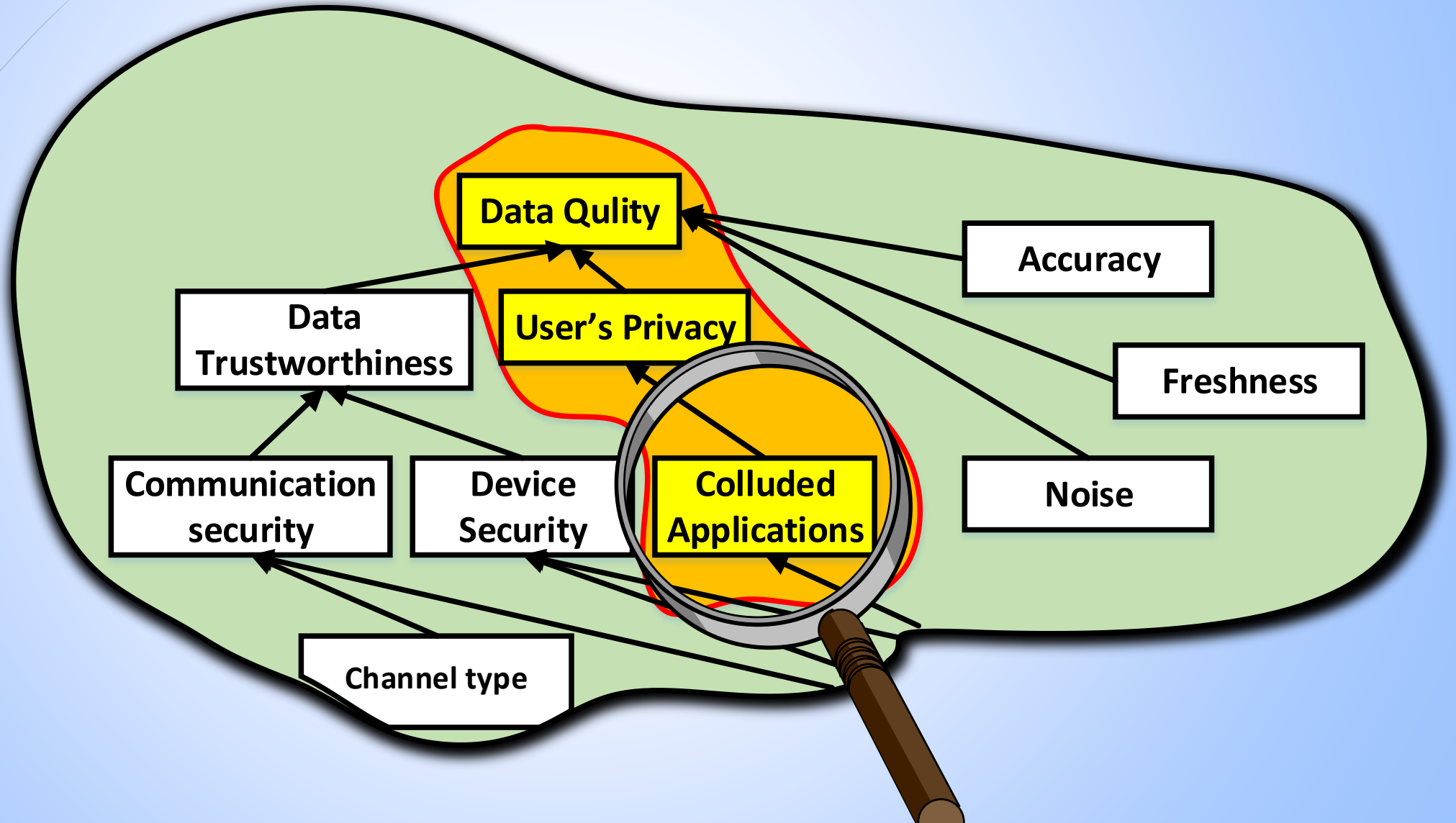
Data Quality

How do we do it?

Our Solution:

A Cyclic Distributed Hierarchical Framework for Data Quality Evaluation and Assurance

Data Quality



What is application collusion?

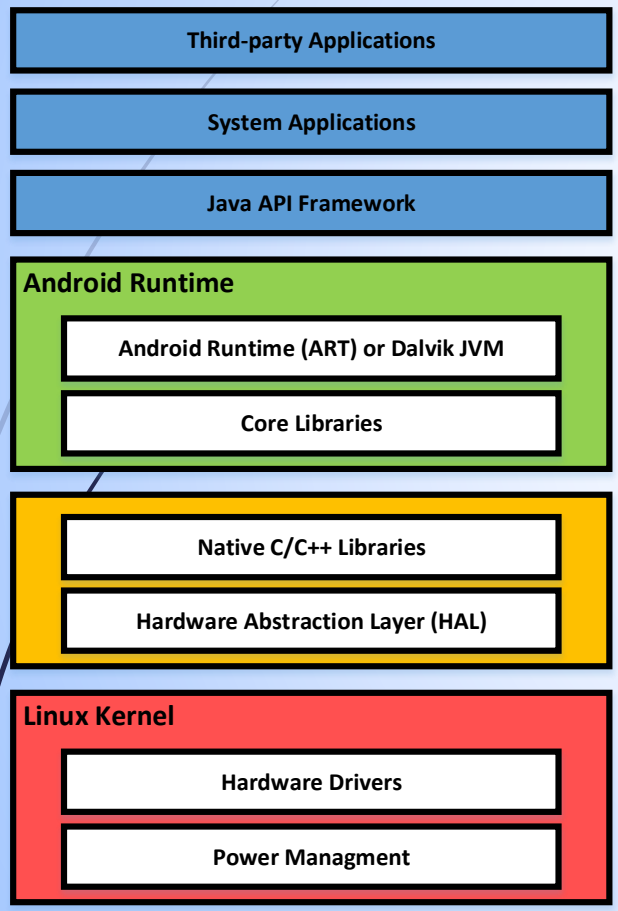
Colluded applications – are collaborating applications that can bypass permission restrictions through communicating with each other.

Applications can communicate with each other either through *overt communication channel* or *covert communication channel*.

Hypothesis

Colluded applications may create distinctive patterns in the memory consumption and CPU usage signals.

Typical Android Architecture

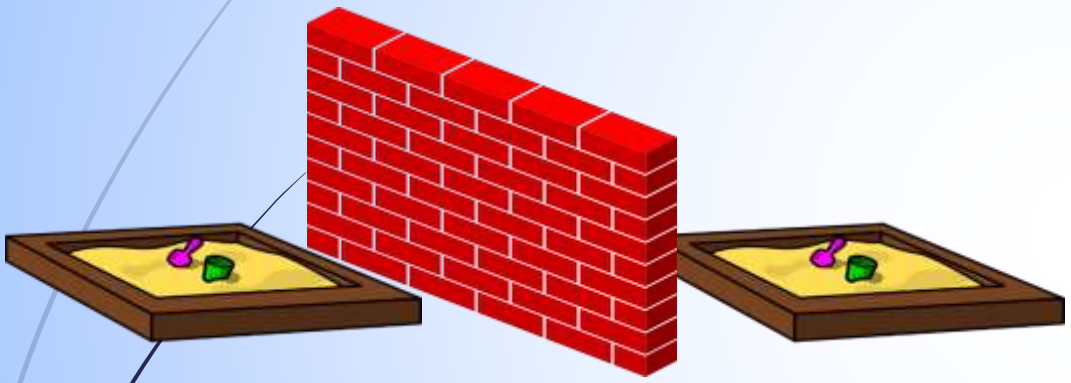


- Application layer
- Android Runtime (ART) executes Java code
- (HAL) provides standard interfaces of hardware components.
- Native C/C++ Libraries layer contains high performance libraries.
- Linux kernel is the basic layer that communicates with platform hardware and sensors.

Source: "Platform Architecture | Android Developers." [Online]. https://developer.android.com/guide/platform/index.html. Accessed: March 27, 2017.

Colluded applications: violation of major security mechanisms

Sandboxing



Application UID 1

Application UID 2

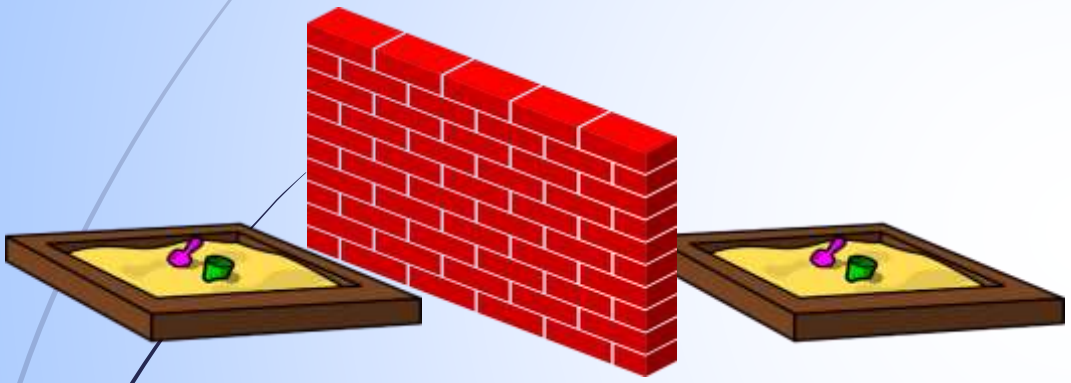
Permissions

In order to use device's resources, an application should ask for a permission

Signature

Colluded applications: violation of major security mechanisms

Sandboxing



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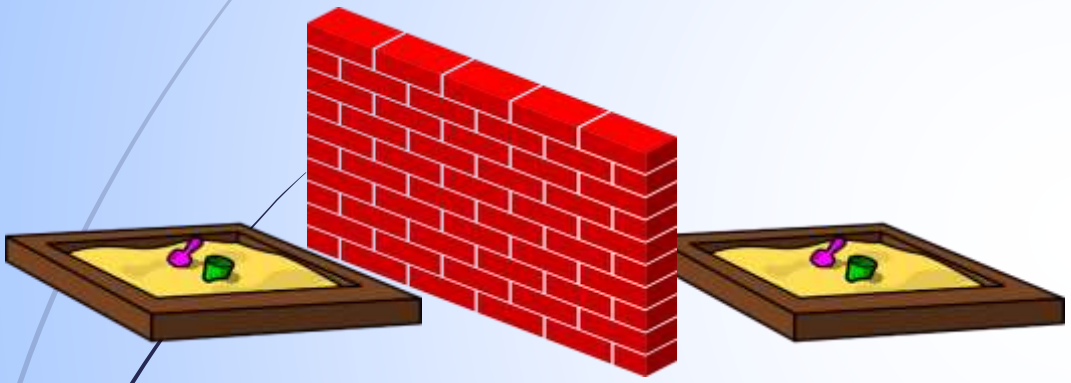

Application UID 1

Application UID 2

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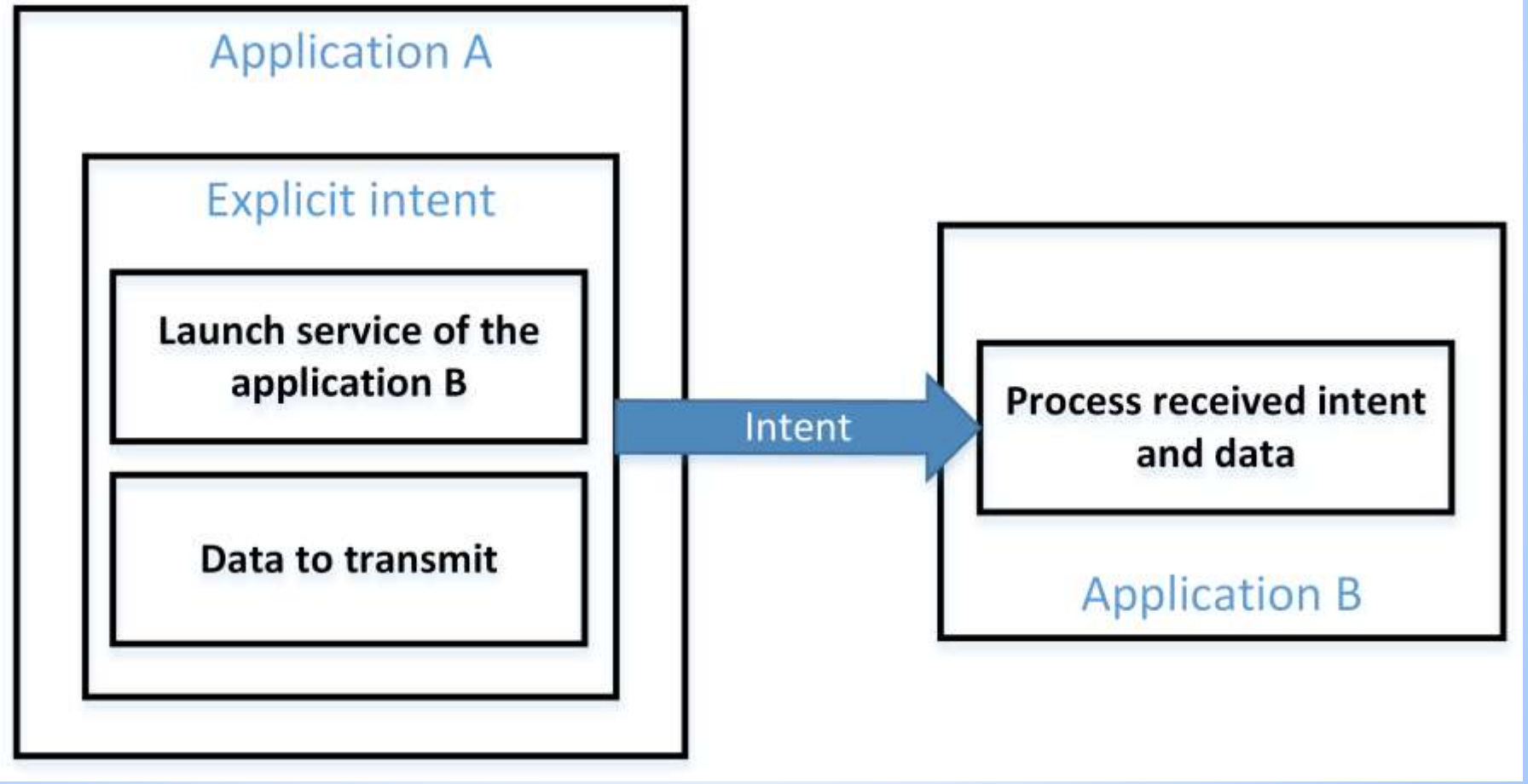
Signature

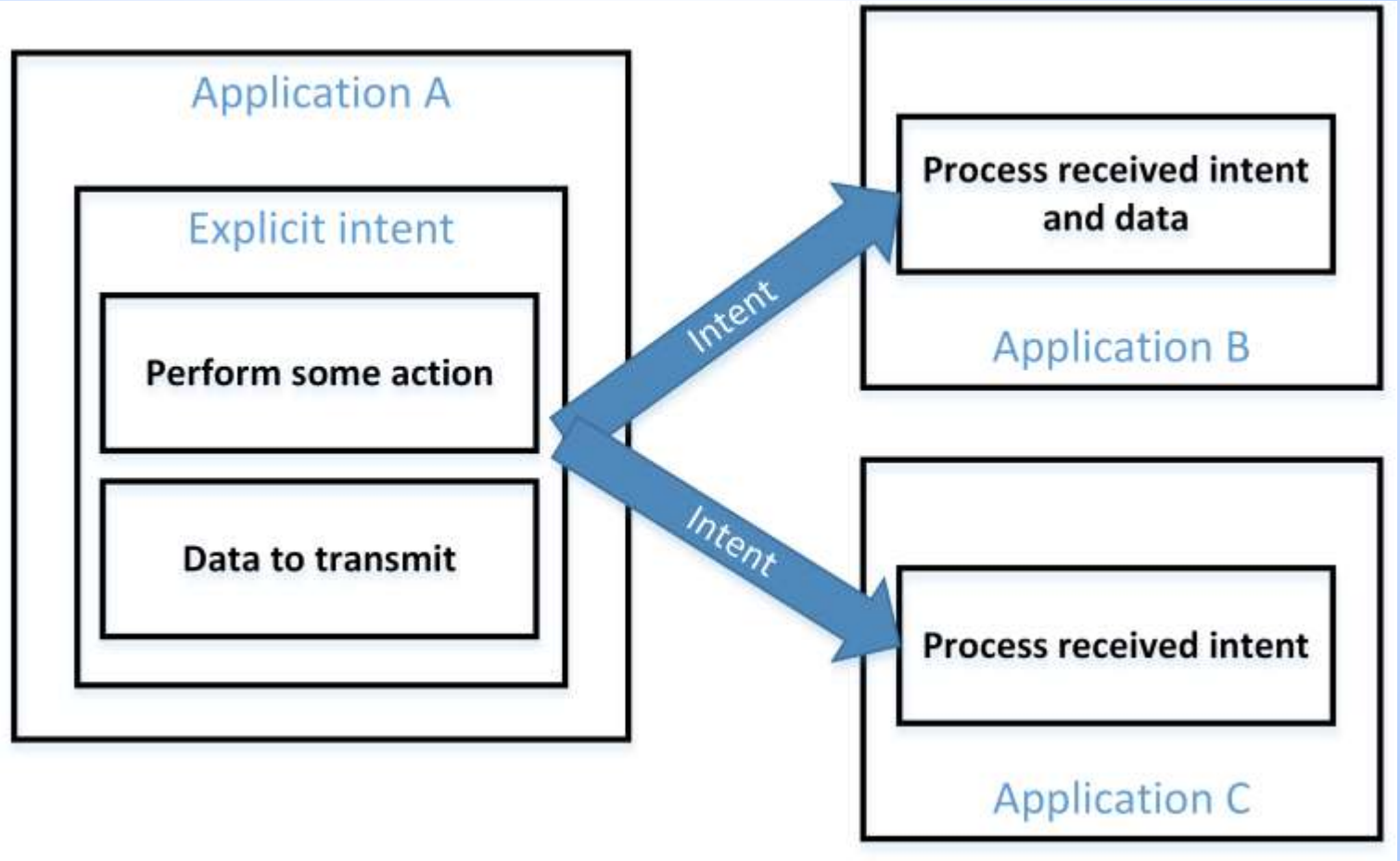
Overt communication channel

Overt communication is used for explicit data transmission between installed applications.

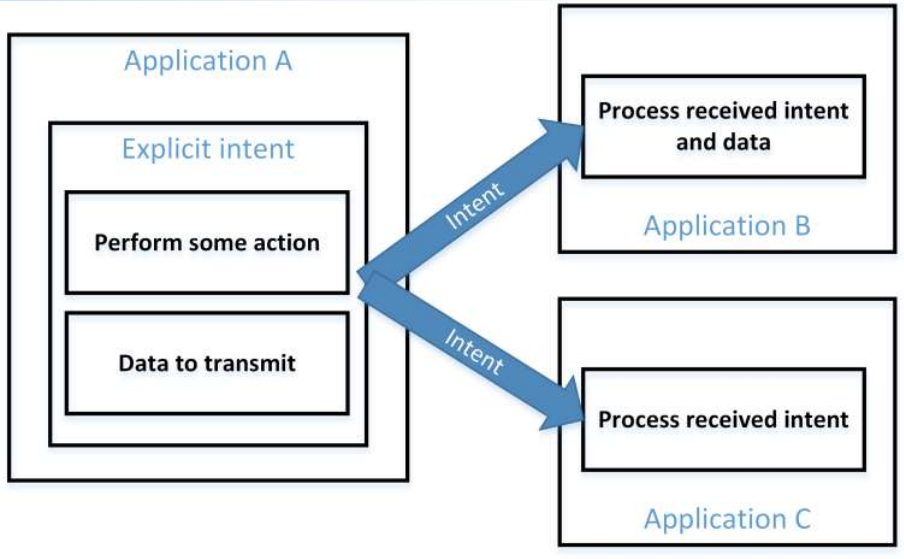
Overt communication channel: Explicit Intent

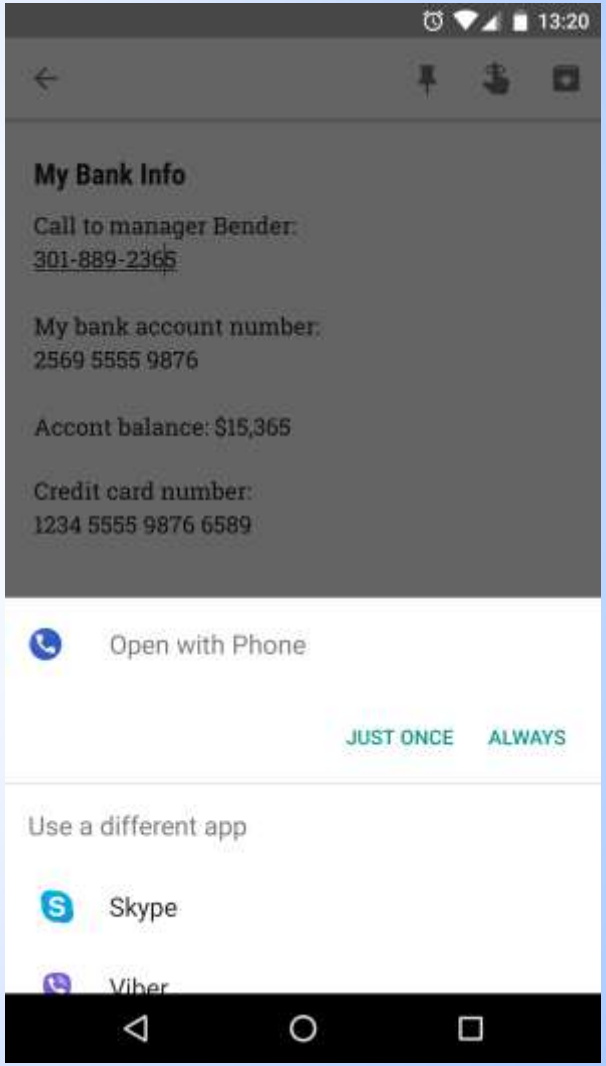


Overt communication channel: Implicit Intent

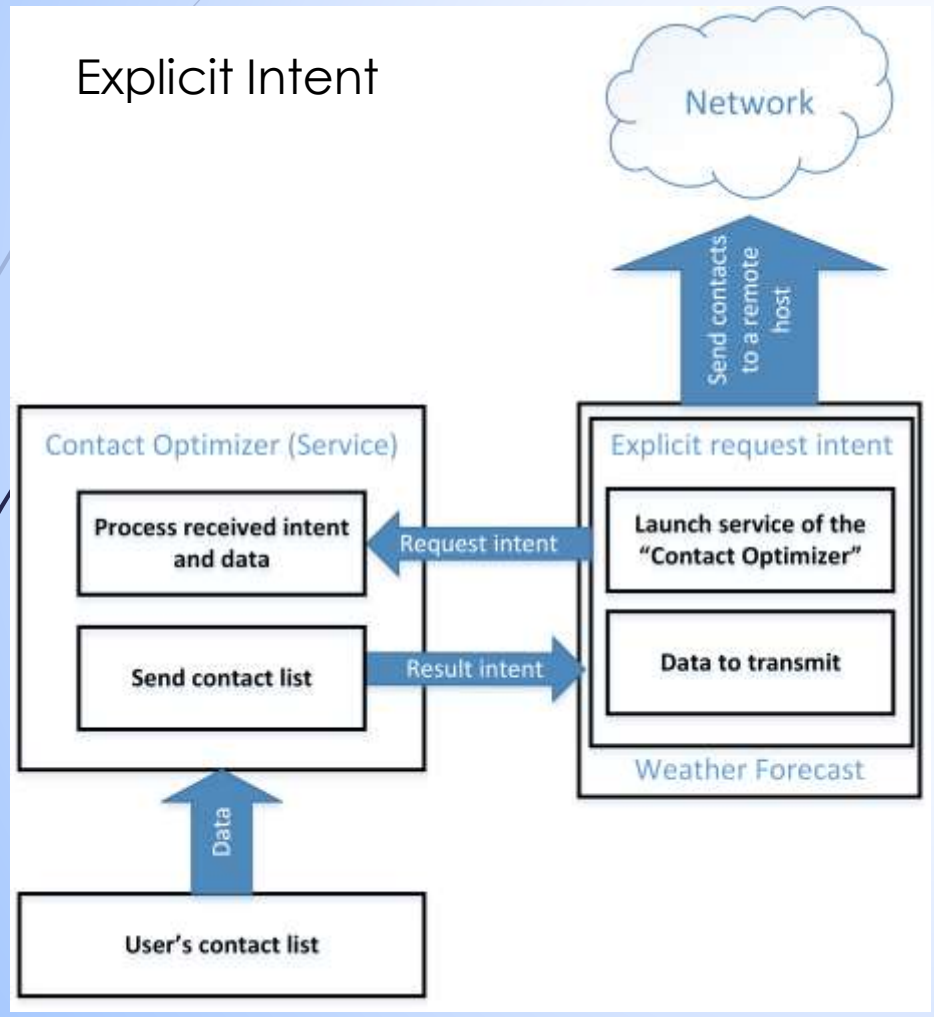


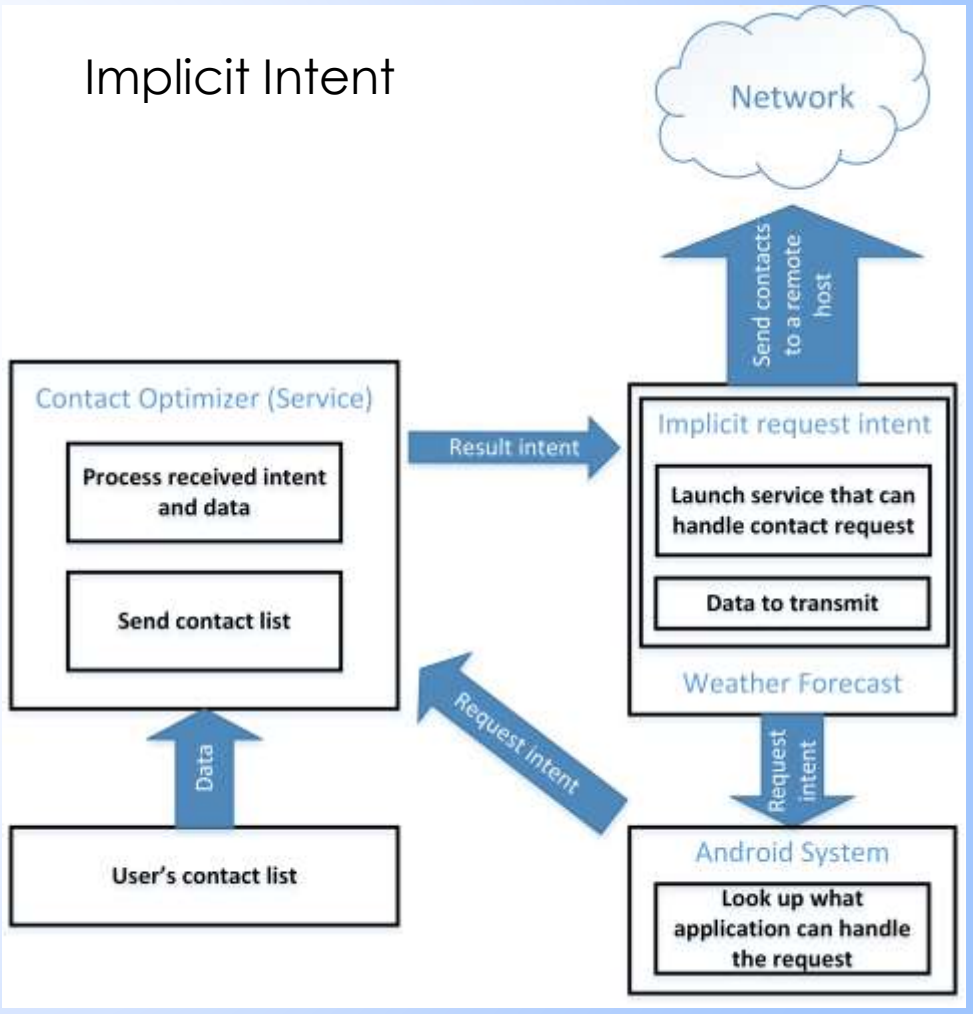
Overt communication channel: Implicit Intent





Overt communication channel: Attack scenario





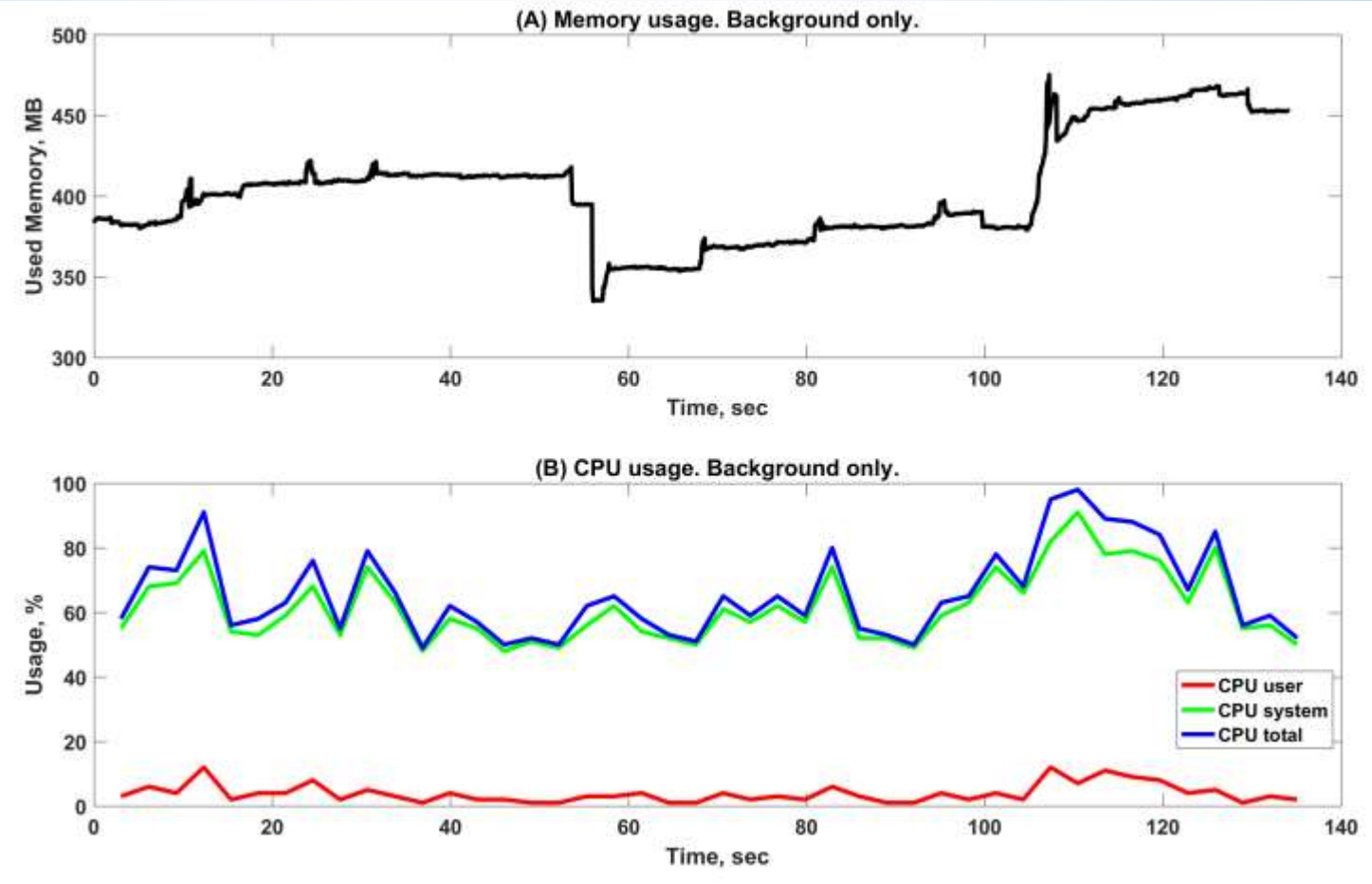
Colluded Applications Defenition

$$(A, B \in S) \Lambda (P_{DA}, P_{DB} \subset DP) \Lambda P_{DA} \neq P_{DB} \Lambda (p_D \in P_{DA}) \Lambda (p_D \notin P_{DB}) \Lambda (p_L \in P_{DB}) \Lambda (p_L \notin P_{DA}) \Lambda t_A(B, D_{pD}, background) \rightarrow A \text{ and } B \text{ are colluded}$$

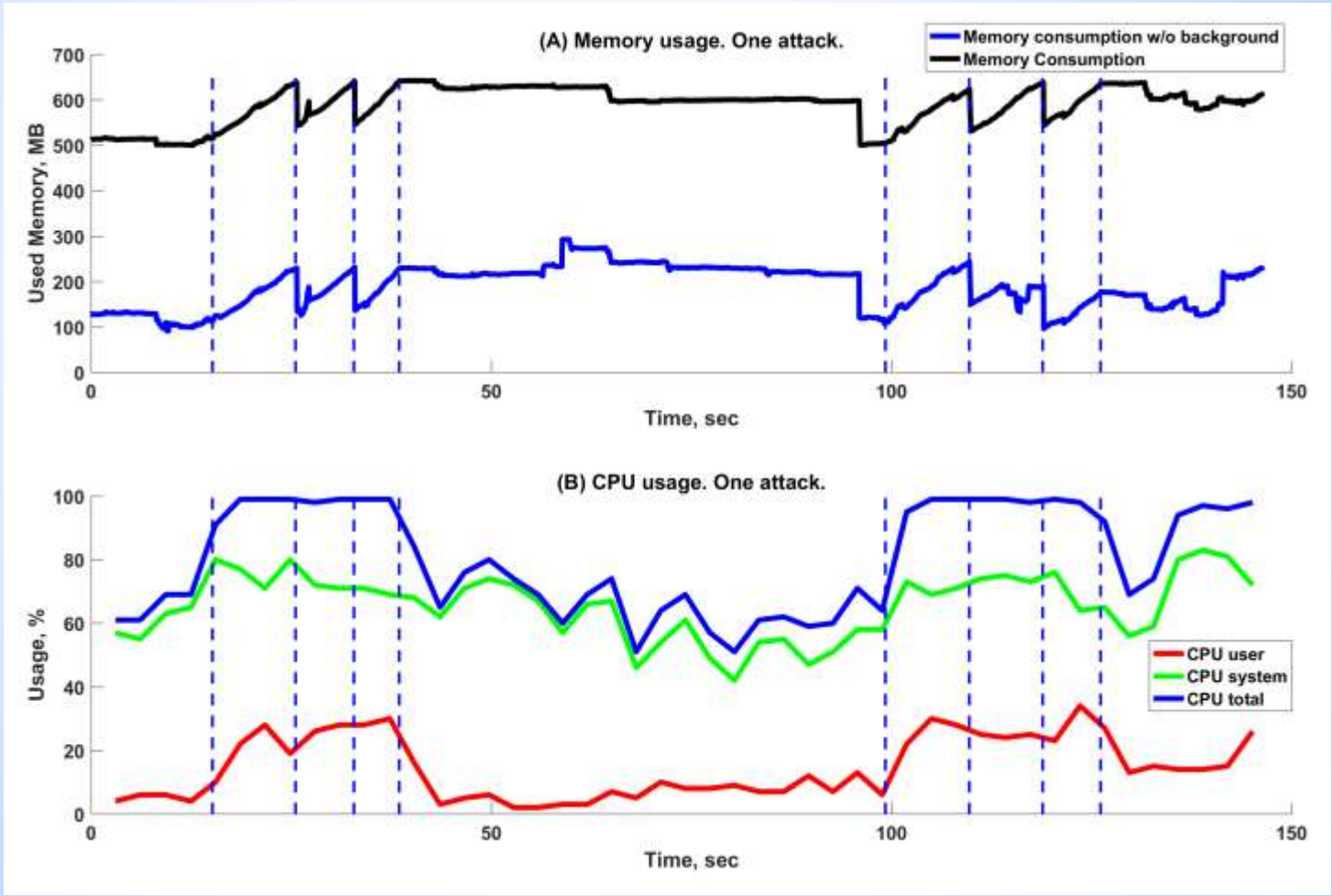
Initial Experiment Description

- Device: Google Nexus 4
- Android version 5.1
- Colluded applications do not follow up normal procedures for retrieving user's data, which commonly have to request permission for data acquisition
- Colluded application transfer data using Android OS services
- Transmitted data: 300 MB of user's data
- Chrome web-browser runs at the background

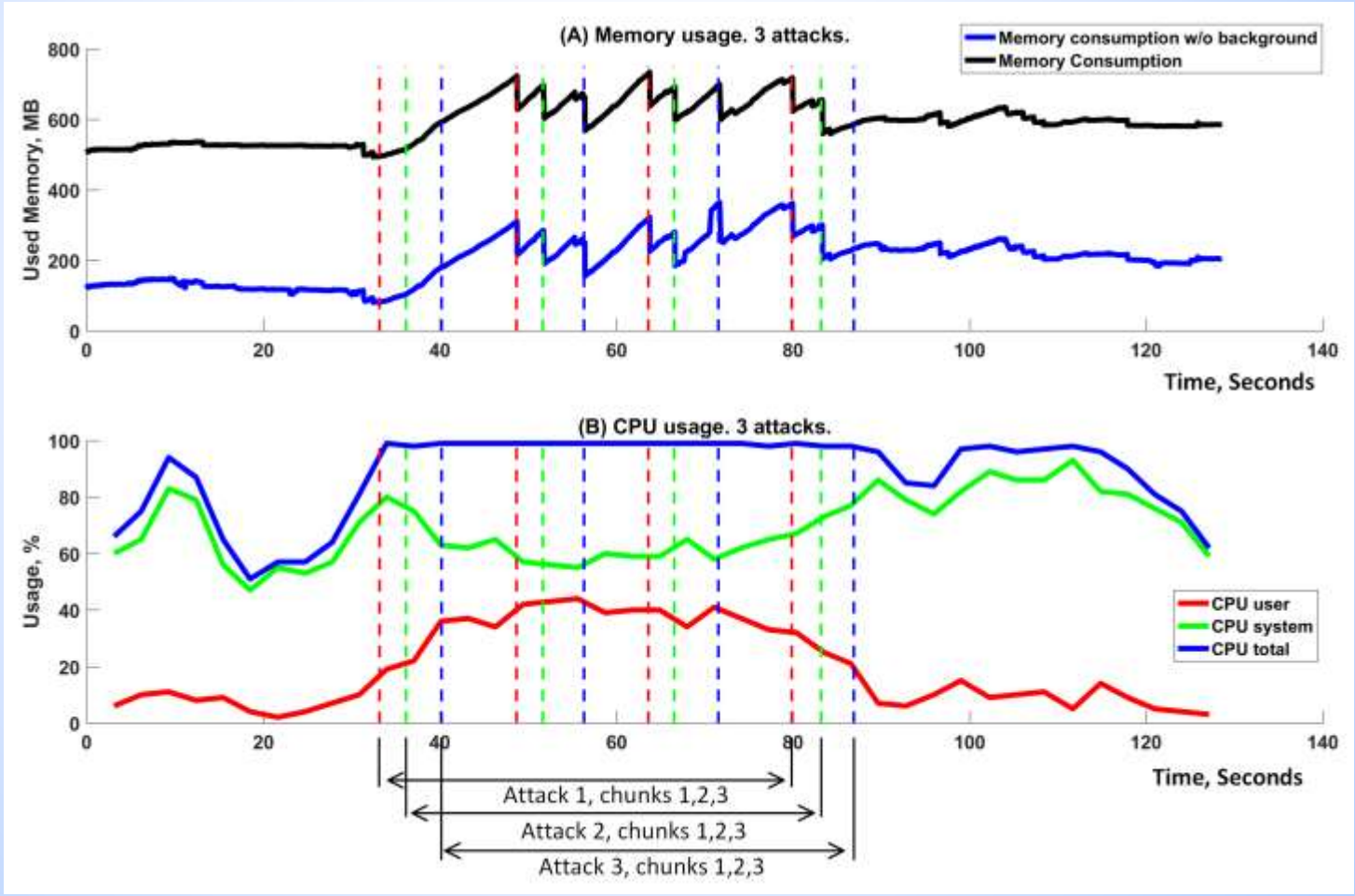
Overt communication channel: Attack analysis – no attacks



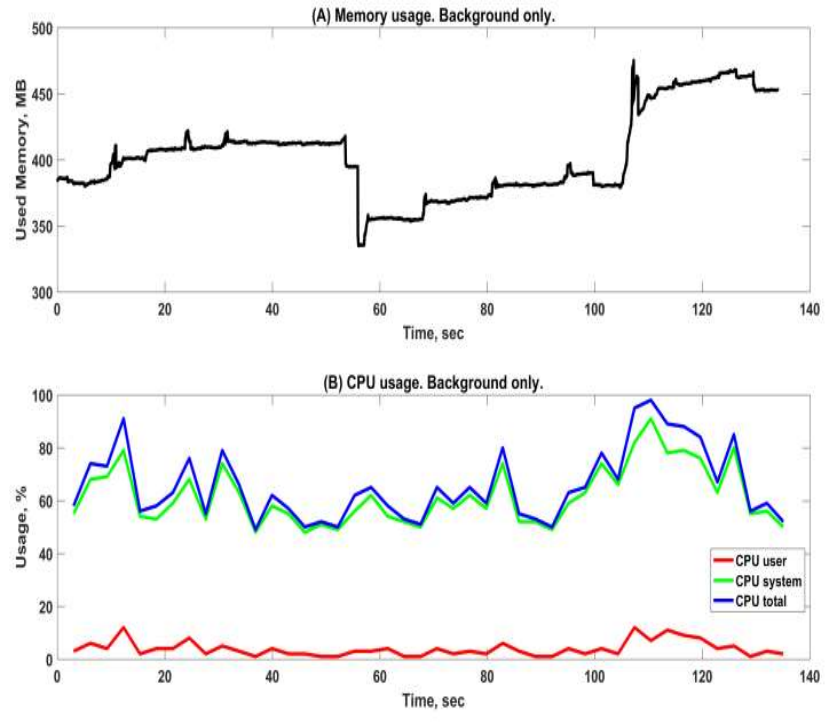
Overt communication channel: Attack analysis – 1 attack at a time



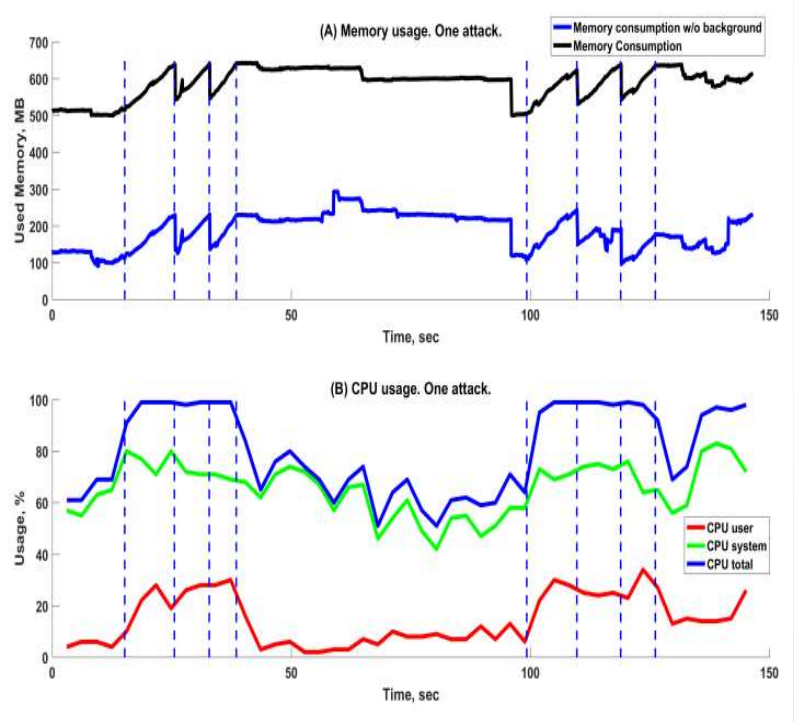
Overt communication channel: Attack analysis – 3 attacks simultaneously



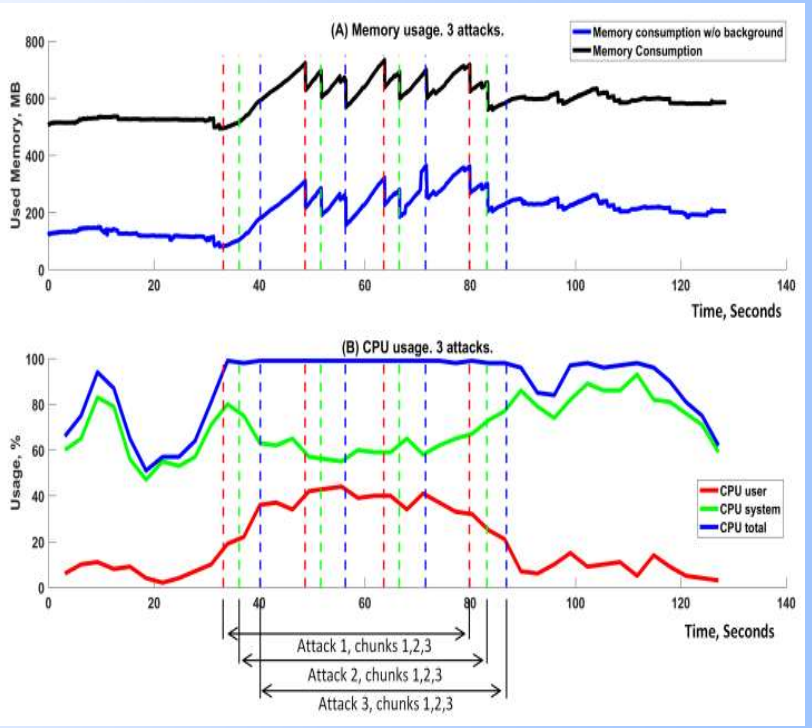
Overt communication channel: Attack analysis - comparison



No Attack



1 Attack

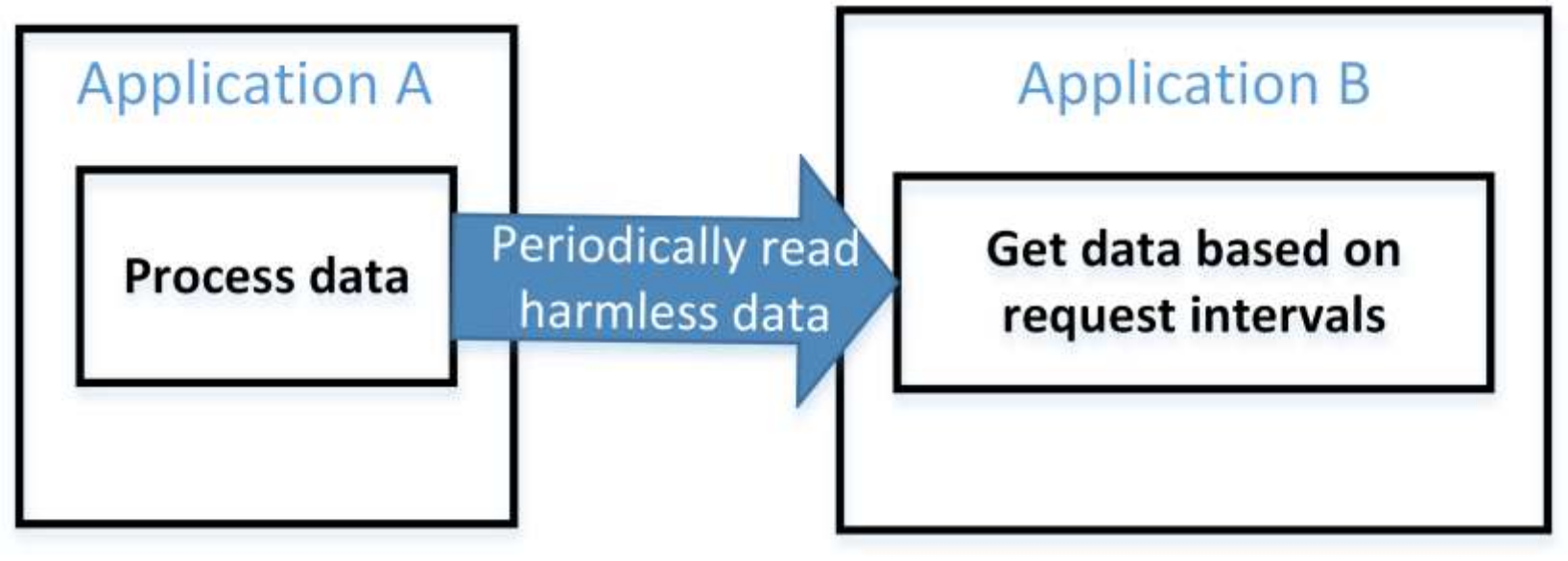


3 Attacks

Covert communication channel

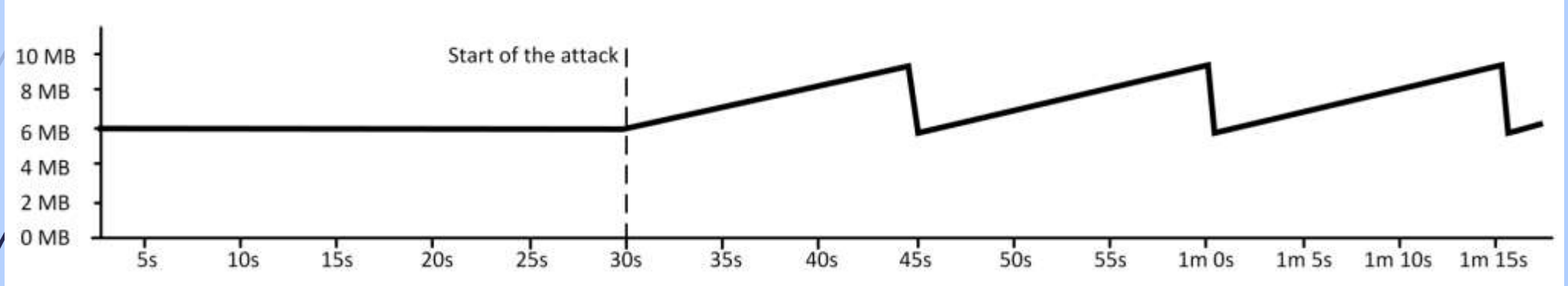
Covert inter-application communication creates a capability to transfer data between applications that are not supposed to be allowed to communicate.

Covert communication channel: Time based



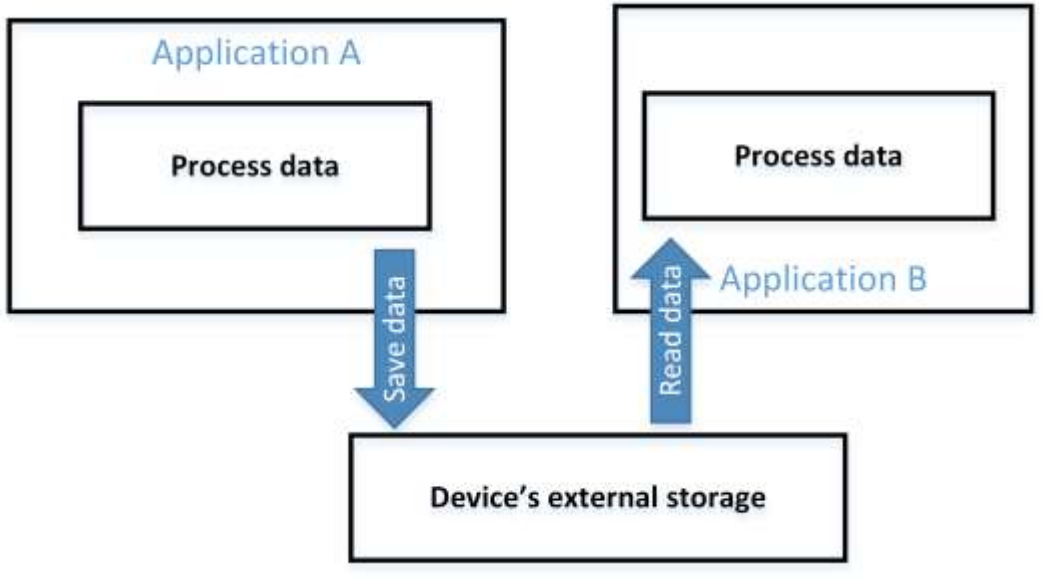
Covert communication channel: Time based – attack analysis

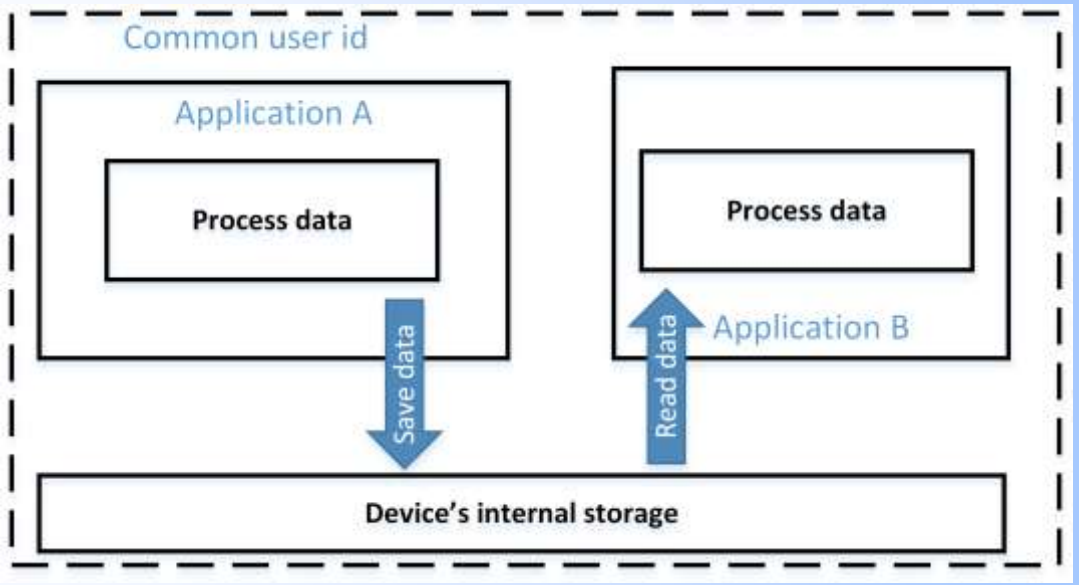
Allocation memory consumption



- Minimal time interval between requests is 1ms;
- 125 bytes per second – expected to be used for small amount of data
- A device cannot go into a sleep mode
- We have not detected patterns in the CPU usage

Covert communication channel: Storage based





Conclusion

- Colluded applications can bypass permissions and cause leak of a private information
- Time-based covert channel is not expected to be used for communicating big amounts of data
- Transferring big amounts of data through Intents creates distinguishing patterns in memory consumption and CPU usage
- These patterns can be used for application collusion detection in a real-time

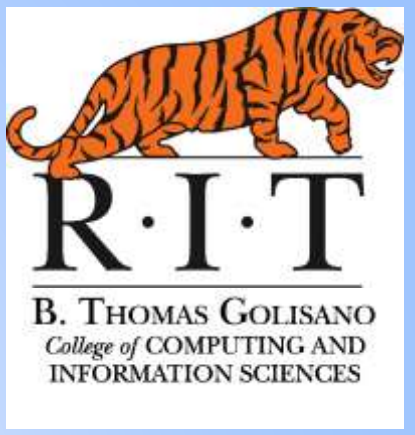
More information?

- Download our apps from Google Play https://play.google.com/store/apps/details?id=com.igorkh.trustcheck.securitycheck
- https://play.google.com/store/apps/details?id=dataqualitylab.rit.ver_app_finder and more are coming
- Watch our webinar: https://youtu.be/nkp0kvJvTWw
- Take a look at our publications (next slide)
- And yes, we are developing the project website
- Contact us

Leon Reznik, Igor Khokhlov
Department of Computer Science
Rochester Institute of Technology
email: lr@cs.rit.edu, ixk8996@rit.edu

Publications

1. Khokhlov, I., Reznik, L., "Colluded Applications Vulnerabilities in Android Devices". The 15th IEEE International Conference on Dependable, Autonomic and Secure Computing (DASC 2017), Orlando, FL, November 2017.
2. Khokhlov, I., Reznik, L., "Android System Security Evaluation". Demonstration. IEEE Consumer Communications & Networking Conference, Las-Vegas, NV, January 2018.
3. Khokhlov, I., Reznik, L., Kumar, A., Mookherjee, A. and Dalvi, R., "Data Security and Quality Evaluation Framework: Implementation Empirical Study on Android Devices." In IEEE Information Security and Protection of Information Technologies Conference, St. Petersburg, April 2017.
4. Khokhlov, I., Reznik, L., "Data Security Evaluation for Mobile Android Devices." In IEEE Information Security and Protection of Information Technologies Conference, St. Petersburg, April 2017.
5. Vora A., Reznik, L., Khokhlov, I.,"Mobile Road Pothole Classification and Reporting with Data Quality Estimates". IEEE MobiSecServ 2018 - Fourth Conference On Mobile And Secure Services, Miami Beach, FL, February 2018. Pages 26-31



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