Telecom system security

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Based on Ross Anderson’s “security engineering” chapter 20

Lecture content

-Phone phreaking.

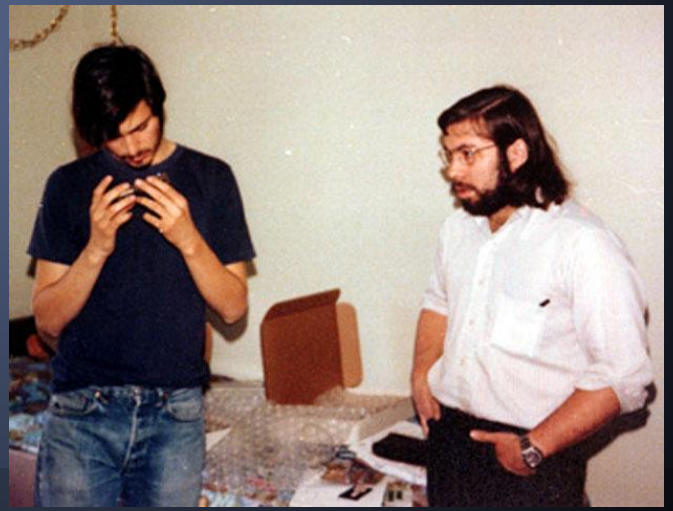
-Mobile phones.

www.theatlantic.com/technology/archive/2013/02/whatever-happened-to-the-phone-phreaks/273332/

Phone Phreaking

-Phreaking is a slang term similar to hacking, meaning “interacting with a system in an unexpected way”.

http://www.digitaltrends.com/apple/phone-phreaking-archive-available-online/#!HKXjd



Phone Phreaking - Signaling

-Until the 80s phone companies used the same physical line for both speech and background signaling.

Phone Phreaking - Signaling cont’

-The User makes a regular call.

-Produce a specific tone(2600 Hz typically). -The tone clears the line on the other side, and the user is left with a clear, payed line.

Phone Phreaking - Signaling Summary

-Later, the same kind of attacks was used to discover and abuse wiretapping signals that the police and agencies used.

-Phone companies slowly built new lines.

Phone Phreaking - Exchanges

-New UNIX based exchanges developed.

Thus exposing the system to attacks on the exchange itself

-A popular target was unlisted celebrity numbers.

Phone Phreaking - Exchanges cont’

-Countries were afraid to purchase exchange and phone systems from foreign countries.

Phone Phreaking - End Systems

-Many products had big security vulnerabilities in them.

-PBXs make a great example.

Phone Phreaking - End Systems cont’

- A PBX, Private Branch Exchange. Is a local telephone exchange. Meant to deal with internal calls and be able to make and receive external calls too.

Phone Phreaking - End Systems cont’

-PBXs came with a special PIN number that enabled low cost calls to long distance numbers. These became known with time and widely used.

Phone Phreaking - End Systems cont’

-New PBXs had a built in remote maintenance option.

-A good feature on one hand. A huge security vulnerability on the other.

Phone Phreaking - End Systems cont’

-A big scale attack of this kind was made in Britain. Over 1 million pounds worth of calls were made to china from some local district council PBX.

Phone Phreaking - End Systems cont’

-The reason behind these kind of attacks is not the free calls, but the anonymity and lack of wiretapping.

Phone Phreaking - End Systems cont’

-Conclusions:

-Think about security!

-Expect the unexpected.

Mobile Phones

-Started at the 80s

-Today the number of mobile phones subscriptions is 6 billion!

Mobile Phones - Cloning

-First generation mobile phones, as with any new technology did not have security features.

-To call, a handset would send its serial number in plain text.

-The base station would then bill the call to that serial number.

Mobile Phones - Cloning cont’

-An attacker with the right equipment could listen to these serial numbers and bill calls to them.

Mobile Phones - Cloning cont’

-A proposed solution was to use cryptography. The problem was that it required hardware changes which are pricy.

-Cloning ended only in the next generation of phones.

Mobile Phones - GSM

-The GSM project security standards was to be “ as good as a wire line”

-The security policy was to keep all the crypto secret.

-This decision was the source of many security vulnerabilities later on.

Mobile Phones - GSM cont’

-So how GSM works.

-Each handset must contain a SIM card (Subscriber Identity Module). The SIM cards are unique, and contain 3 important numbers.

Mobile Phones - GSM cont’

-PIN, a number used by the user to open the SIM card.

-IMSI, the phones ID.

-K, a cryptographic key.

SIM

-PIN(0000)

-IMSI

-K

www.gomonews.com/can-sim-only-deals-damage-mobile-device-sales/

Mobile Phones - GSM

-Whenever the sim card is activated it sends the IMSI to the closest base station.

-The base station authenticates the phone by using a challenge response protocol.

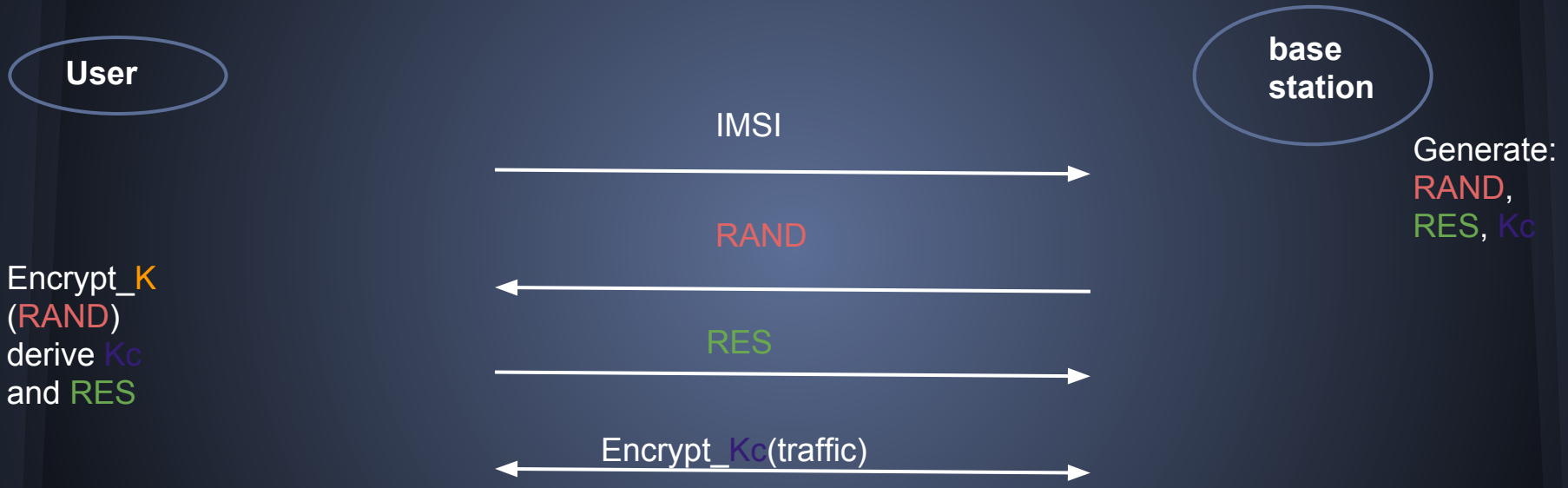
Mobile phones - GSM

-The values are related as follows:

Encrypt_K(RAND)= RES|Kc.

-Kc will be the session's encryption key.

Mobile phones - GSM cont'



Encrypt_K(RAND) = RES|Kc

Mobile phones - GSM cont’

-The original encryption function used in GSM initialization is called comp128.

-Quickly after the design leaked many attacks were found on comp128

Mobile phones - Attacks on GSM

-Another problem was that the base station traffic with the company’s databases was not encrypted or authenticated.

Mobile phones - Attacks on GSM cont’

-The call encryption algorithm was A5.

-A5 was also designed in secret, and again, once the design leaked, many attacks were found.

-Later, a new and more secure version was introduced and called A5/3.

Mobile phones - Attacks on GSM cont’

-A5, or A5/1 had an even weaker variant, A5/2.

-First world countries used A5/1, all other countries(Israel included) used A5/2.

-A5/2 is still being used today.

Mobile phones - 3G

-It is the latest phone network protocol.

-3G’s security goals was to achieve what GSM tried to. and support 2 way authentication.

-The whole protocol was public and stood public scrutiny.

Mobile phones - 3G cont’

3G protocol: Uses the same values as GSM.
-3G uses some additional values.

-Ki: The integrity key, used for authentication

-Ka: The anonymity key, used to encrypt SEQ.

-SEQ: A sequence number that changes every connection, used to authenticate the network.

Mobile phones - 3G cont'

User

base station

IMSI →

← RAND, (SEQ xor Ka), MAC

RES →

Encrypt_Kc(traffic) ↔

generate:
RAND
RES, Kc,
Ki,Ka

Encrypt_K
(RAND)
derive all
the keys
and RES

Encrypt_K(RAND) = RES|Kc|Ki|Ka

Mobile phones - 3G cont’

-3G achievements: It is not a revolution in terms of security, but it achieved what GSM meant to achieve.

Mobile phones - success or failure

-To who?

-In the users perspective, it’s hard to bill to you calls that you did not do.

-Authorities and criminals with enough effort can still get to your calls.

-A small improvement.

Mobile phones - success or failure

-In the telephone company’s perspective cloning is not an issue any more which is a great success.

-Users can’t get free calls or anything like that.

-Pretty good for the phone companies.

Mobile phones - success or failure

-From an attacker's point of view it requires more effort to attack the users or the company’s. and no free phones by cloning.

-attackers are in a worse situation, but not that worse.

Mobile phones - success or failure

-Big intelligence agencies are also fine, they have the capabilities to get the data anyway.