Transparent Botnet Control for Smartphones over SMS

Georgia Weidman

Why Smartphone Botnets?

Nearly 62 million smartphones sold in Q2 2010

Development is similar to standard platforms

- Android = Linux
- iPhone = OSX
- Windows Mobile = Windows

Technical specs not as good as top of the line desktops. They are capable and improving rapidly.

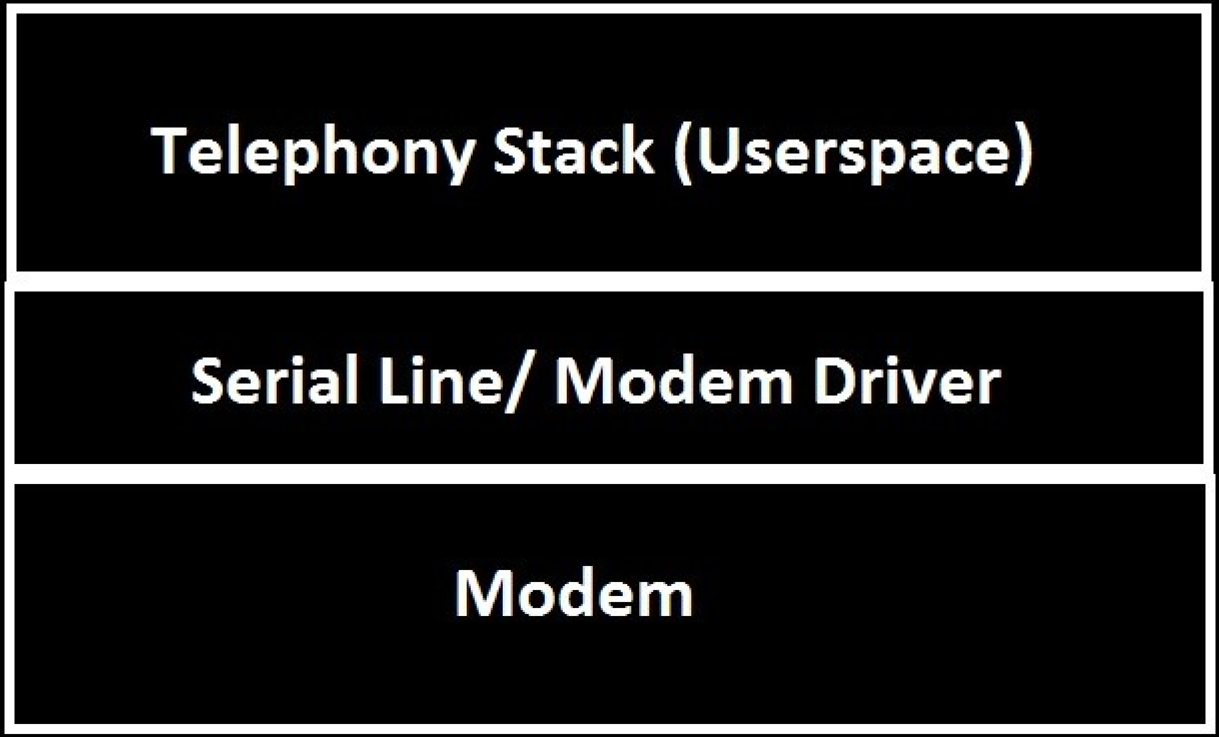
Why SMS C&C?

Battery Management: IP runs down battery quickly

Fault Tolerant: If SMS fails it will queue and retry

Difficult for security researchers to monitor

How an SMS is sent and received

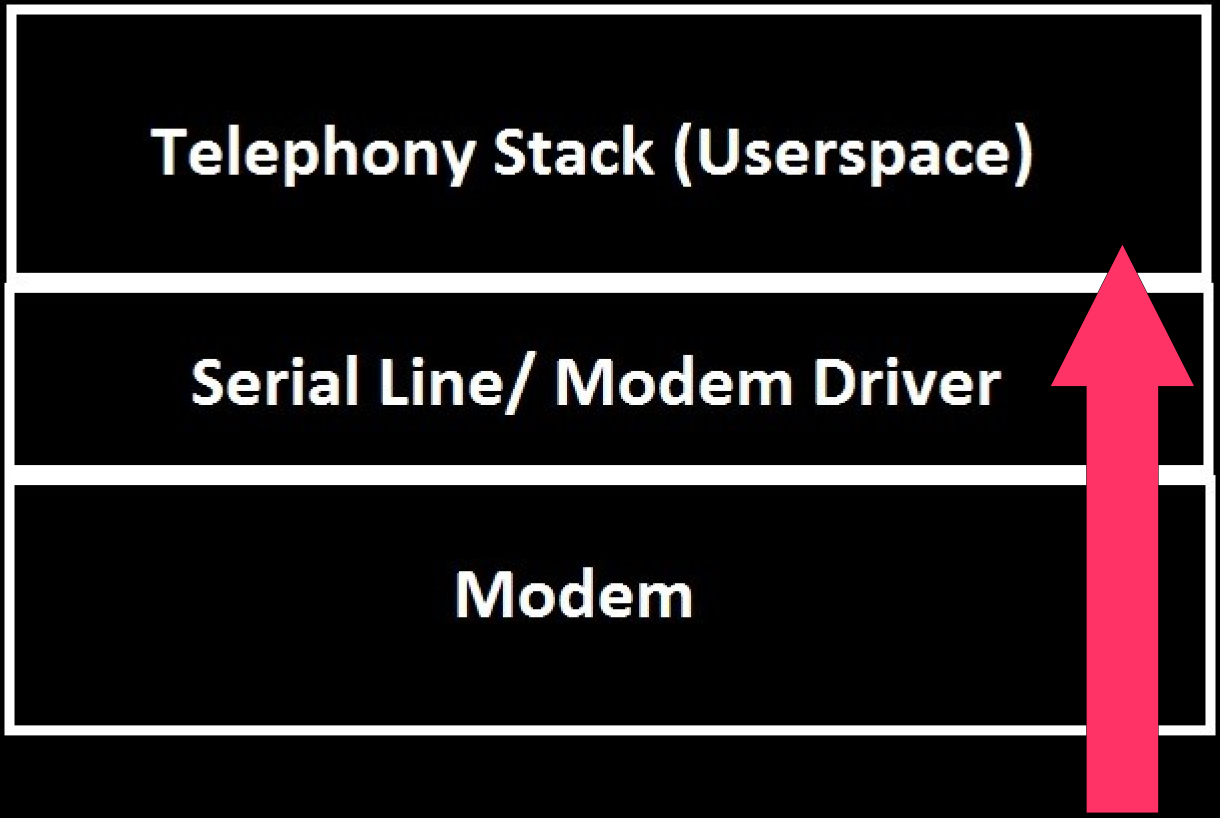


Telephony Stack (Userspace)

Serial Line/ Modem Driver

Modem

How an SMS is sent and received



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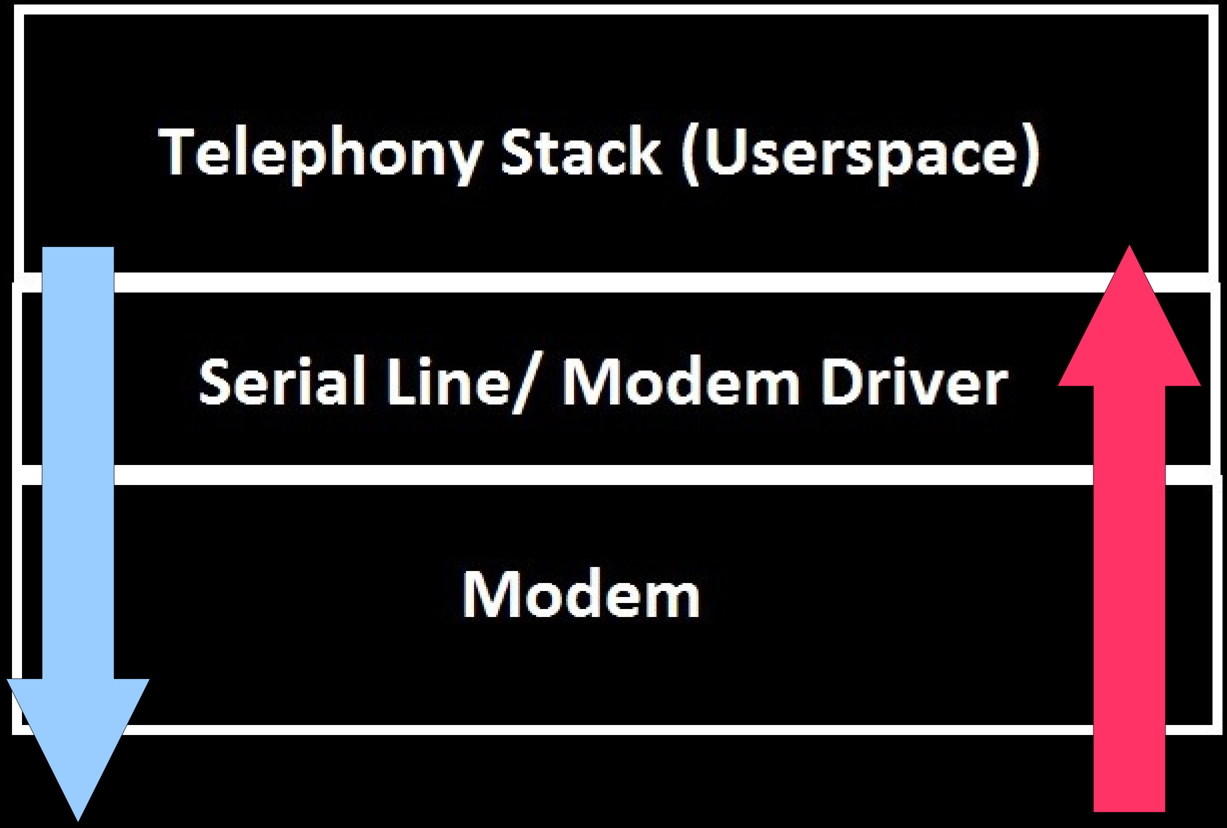

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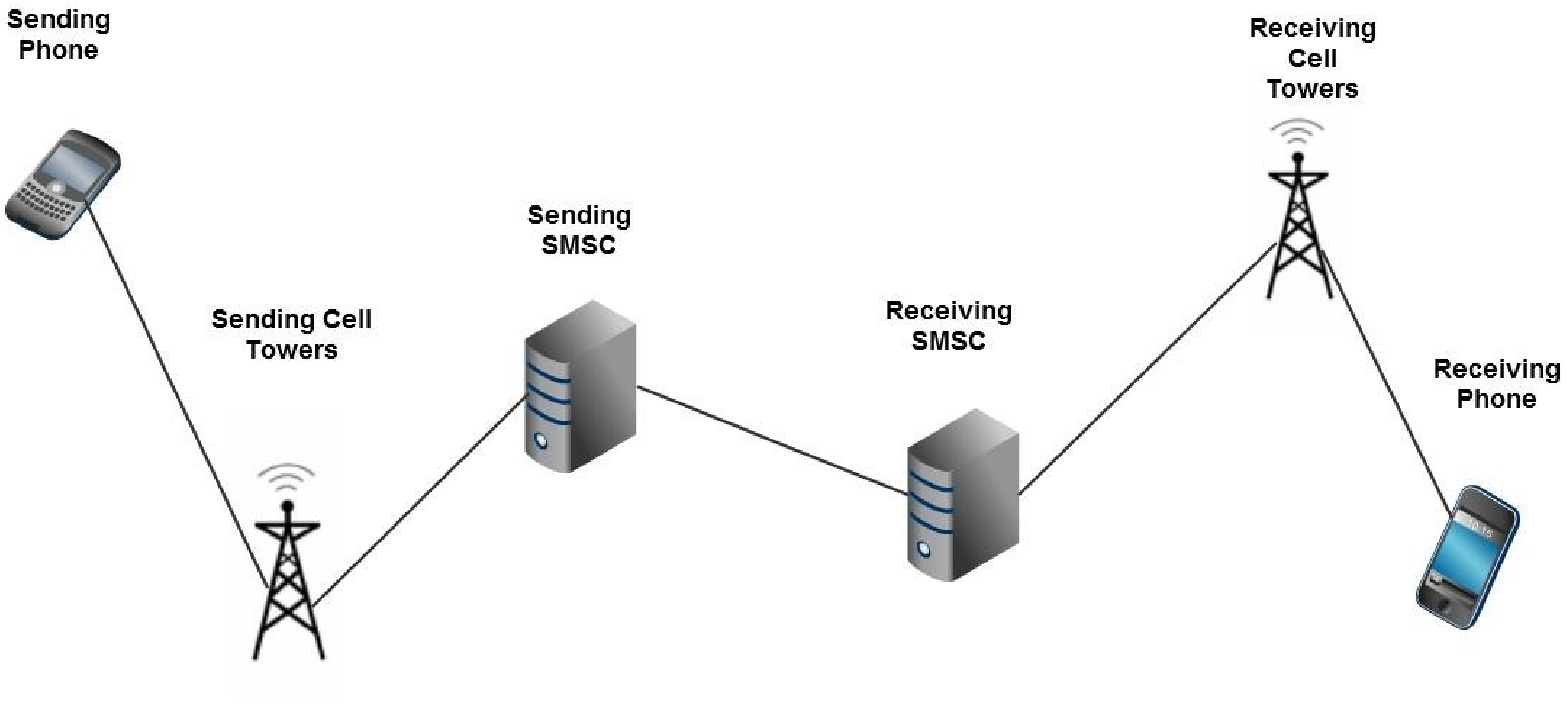

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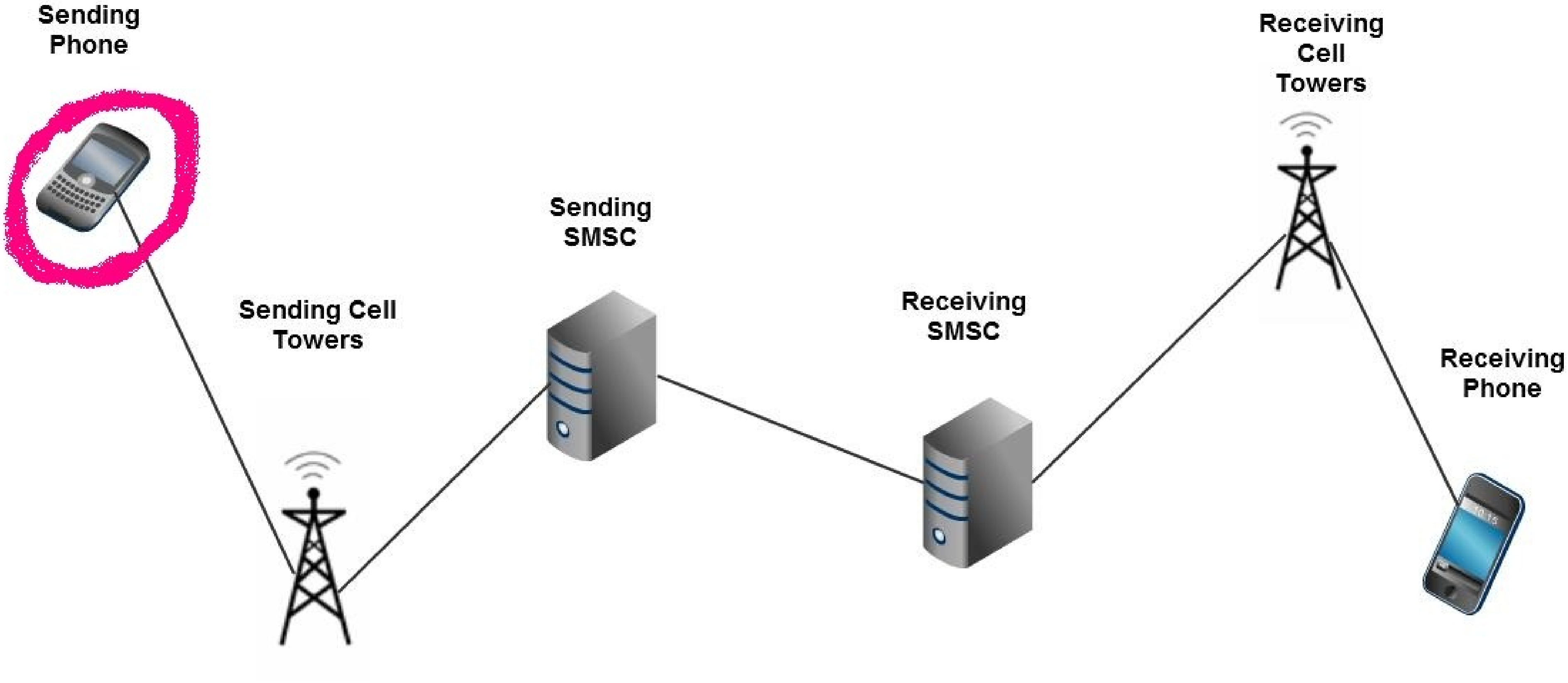

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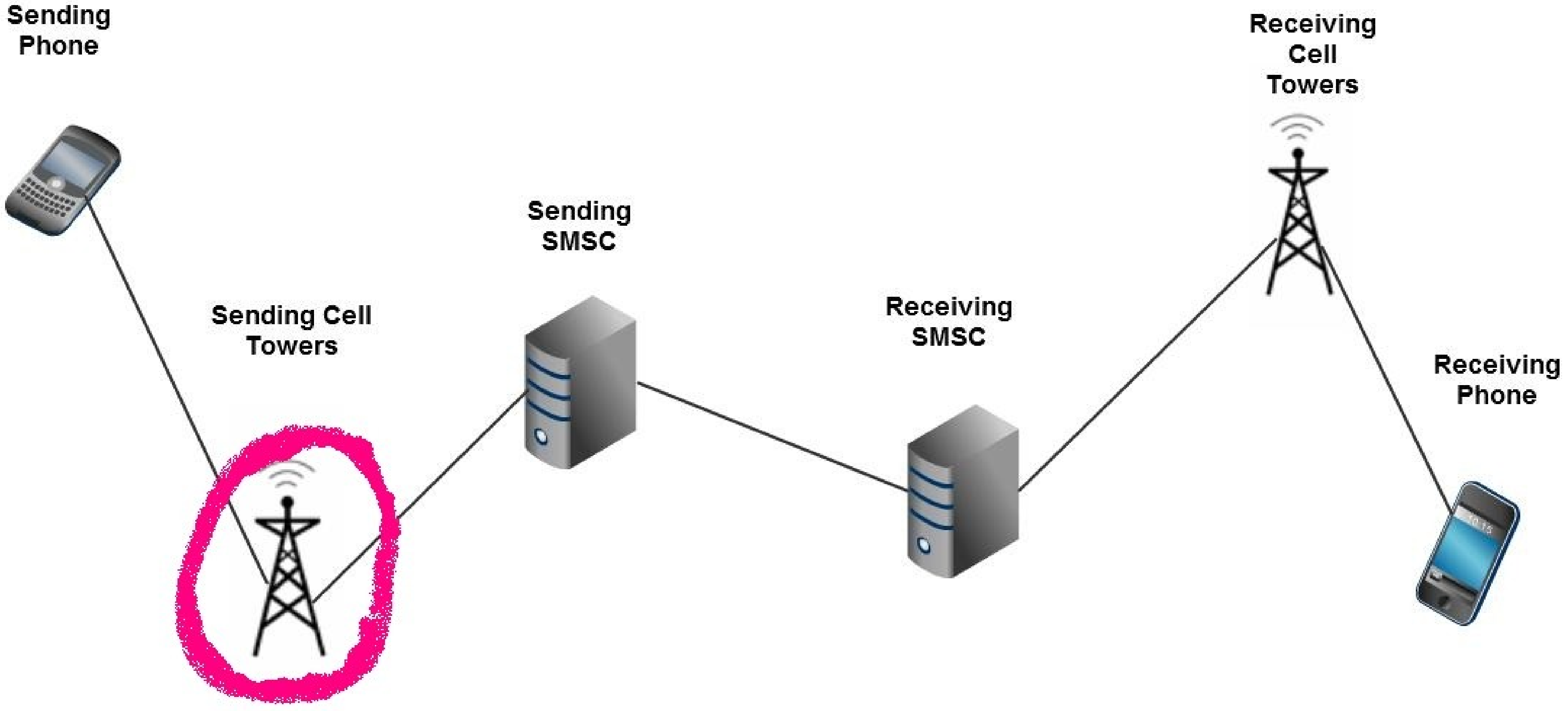

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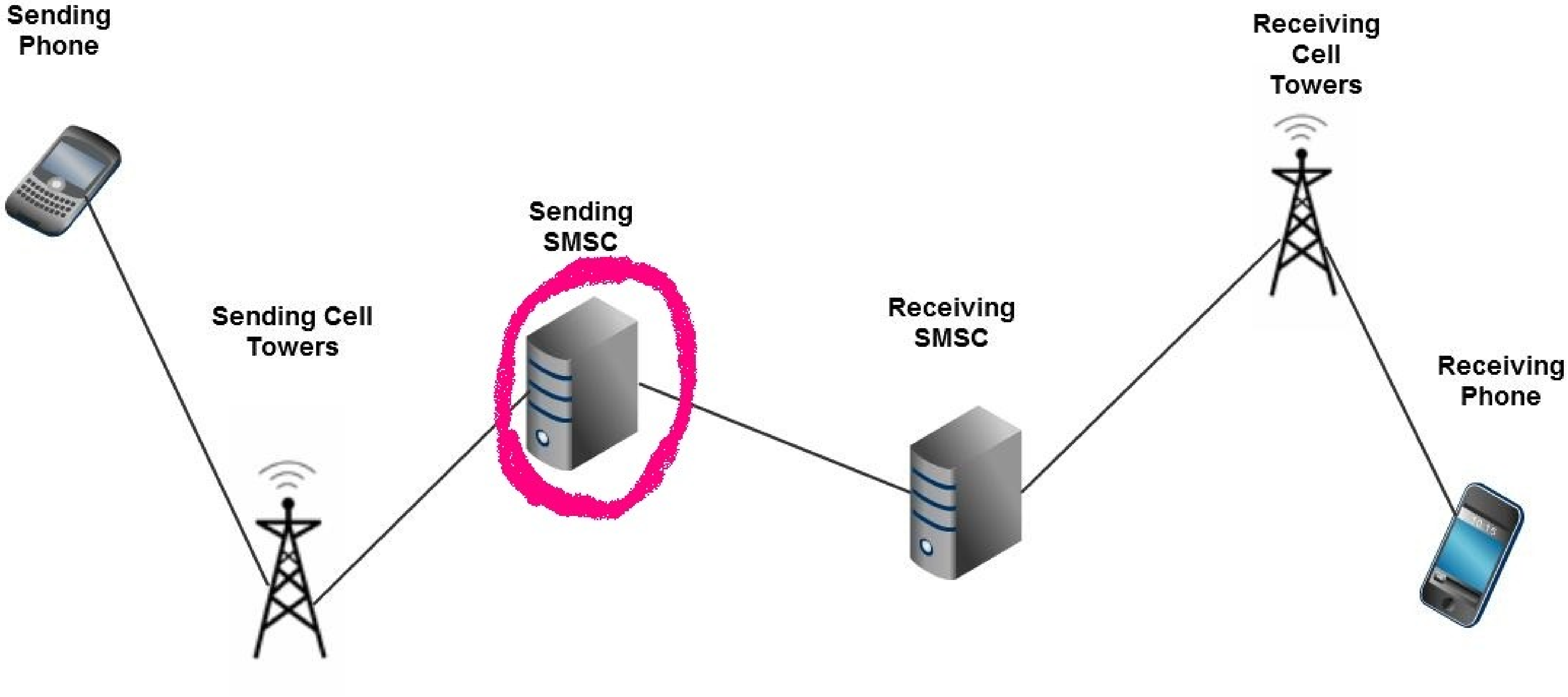

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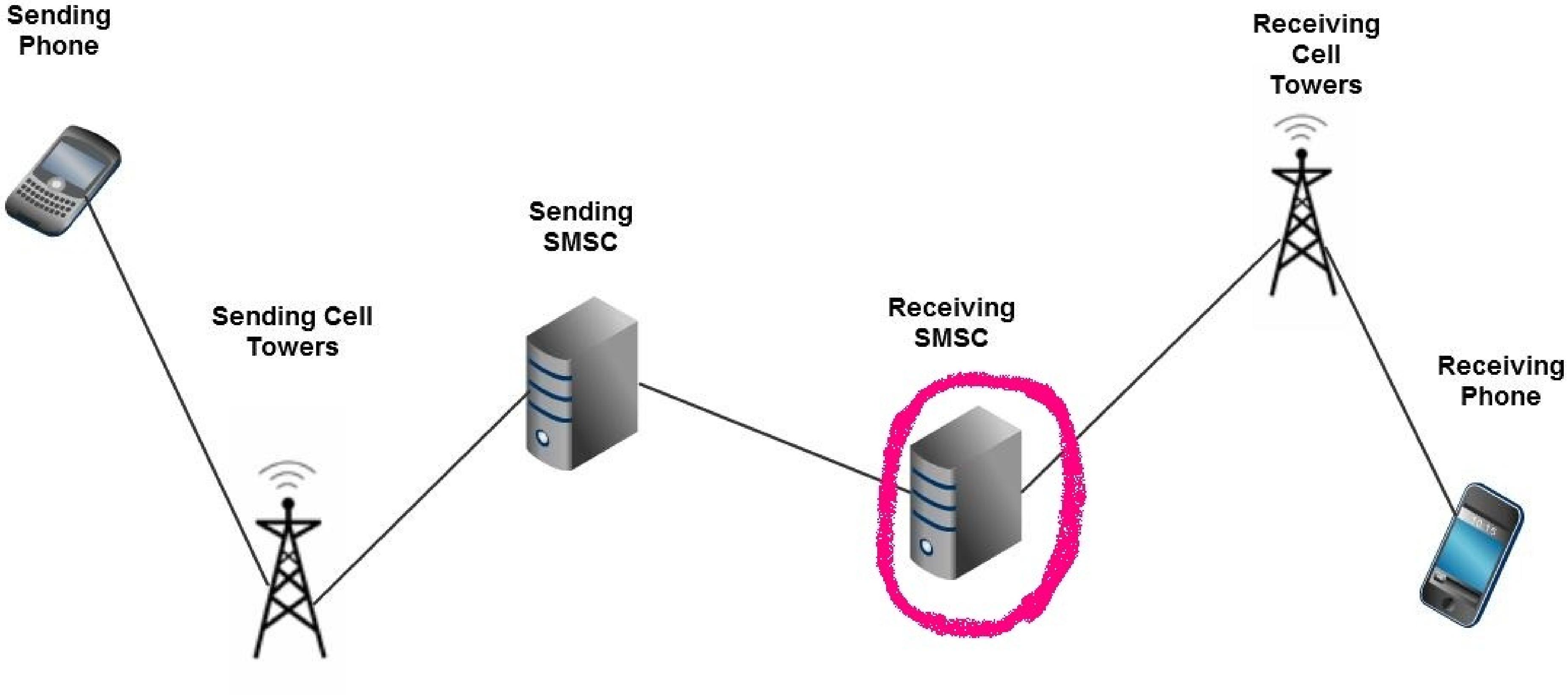

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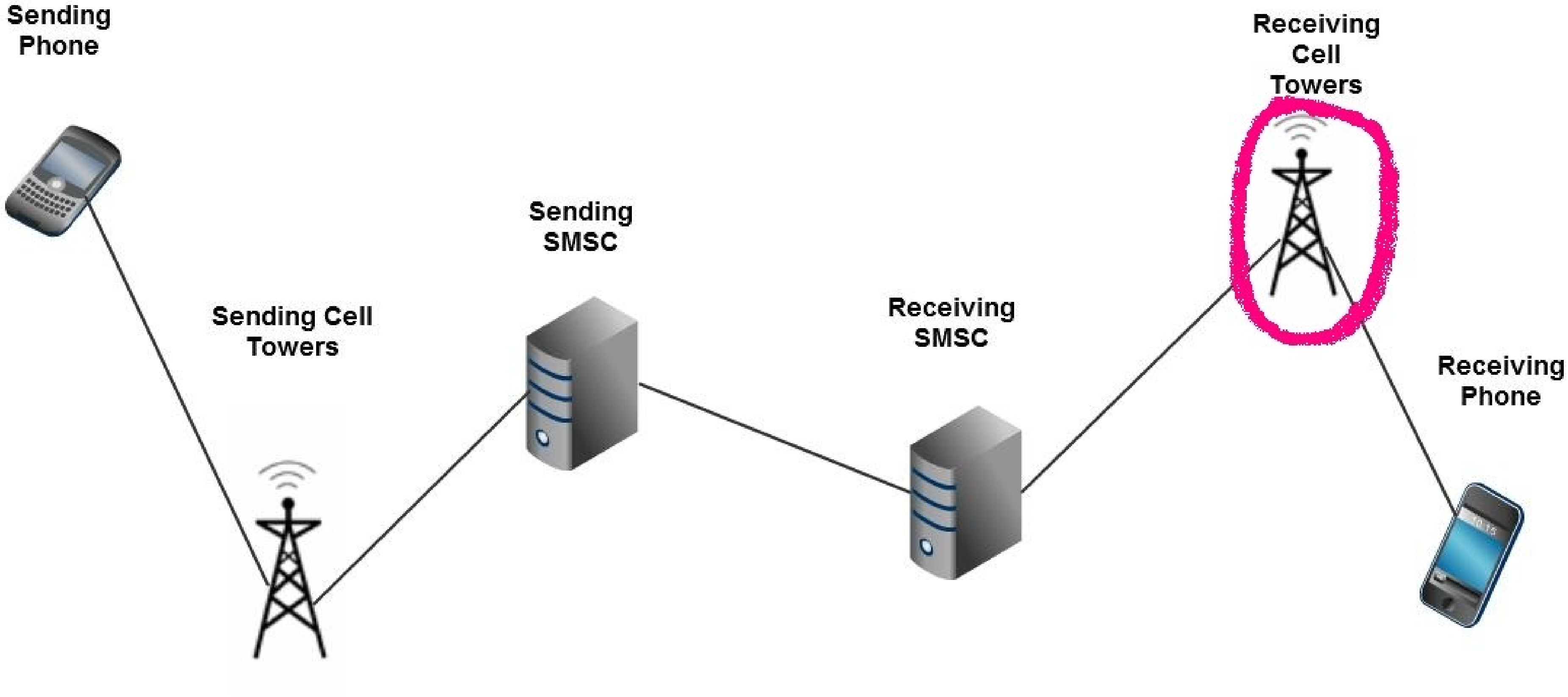

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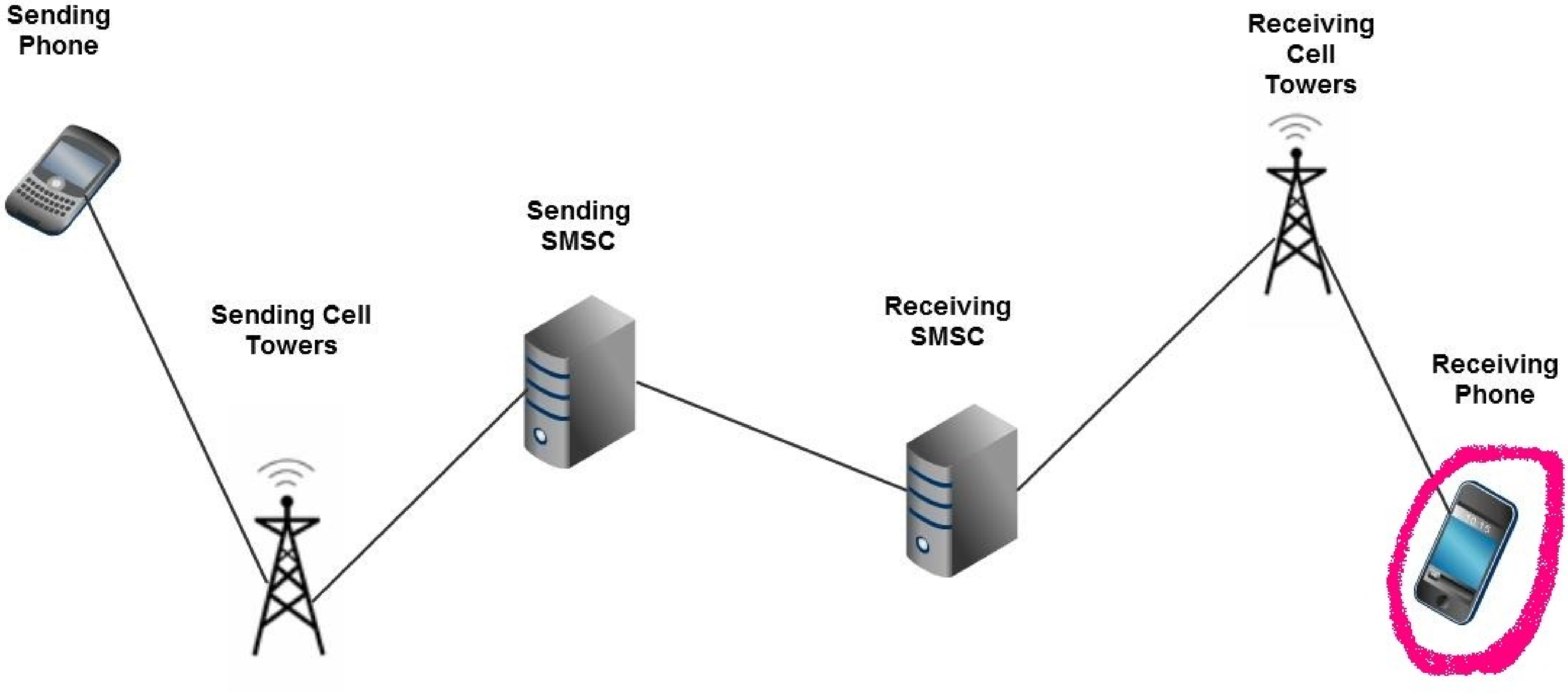

Previous Work: SMS Fuzzing

At Blackhat 2009, Charlie Miller & Collin Mulliner proxied the application layer and modem to crash smartphones with SMS.

http://www.blackhat.com/presentations/bh-usa-09/MILLER/BHUSA09-Miller-FuzzingPhone-PAPER.pdf

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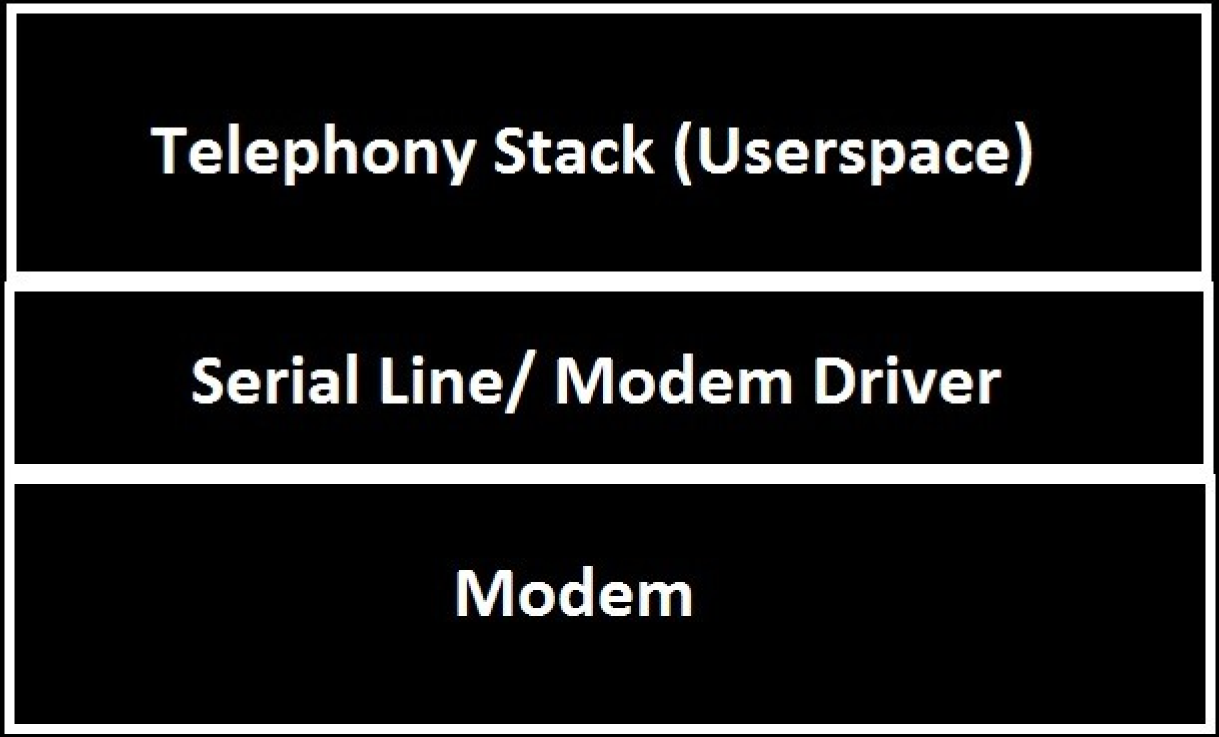

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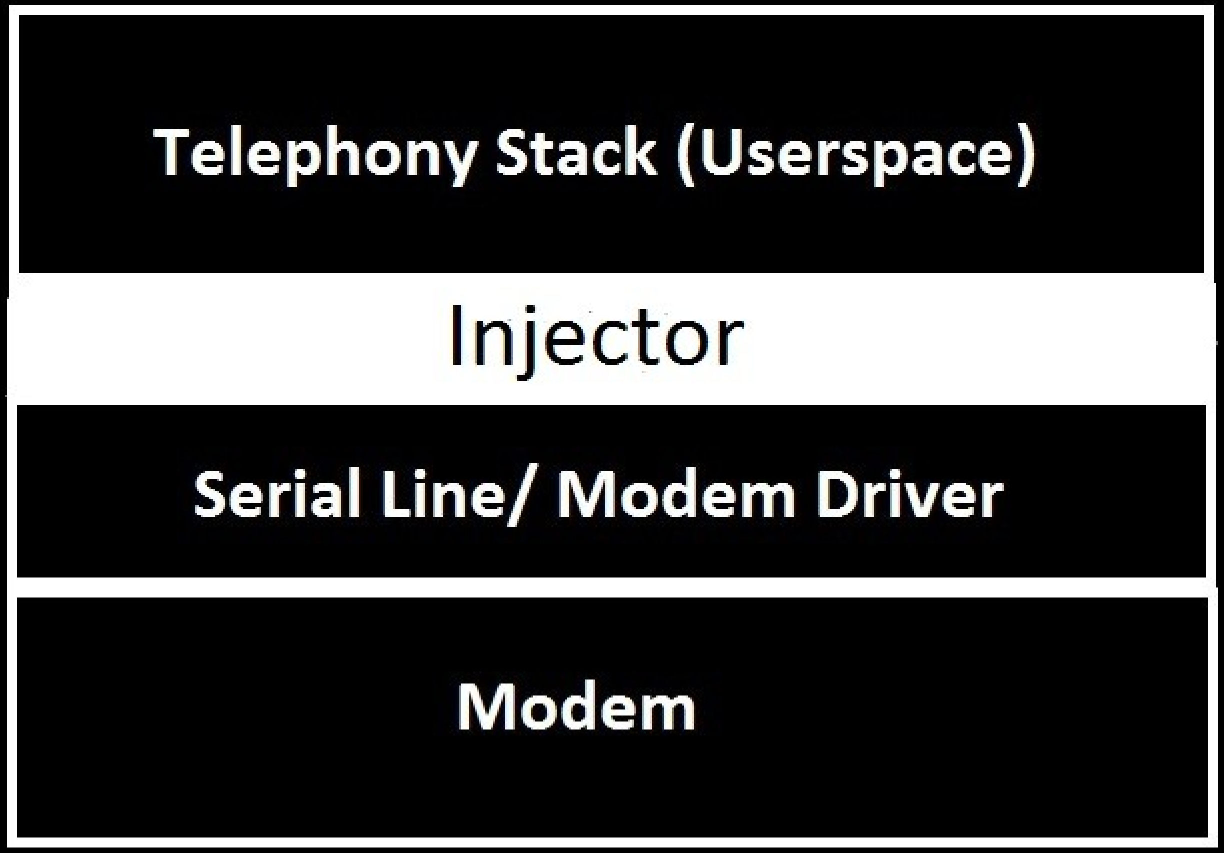

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Injector

Serial Line/ Modem Driver

Modem

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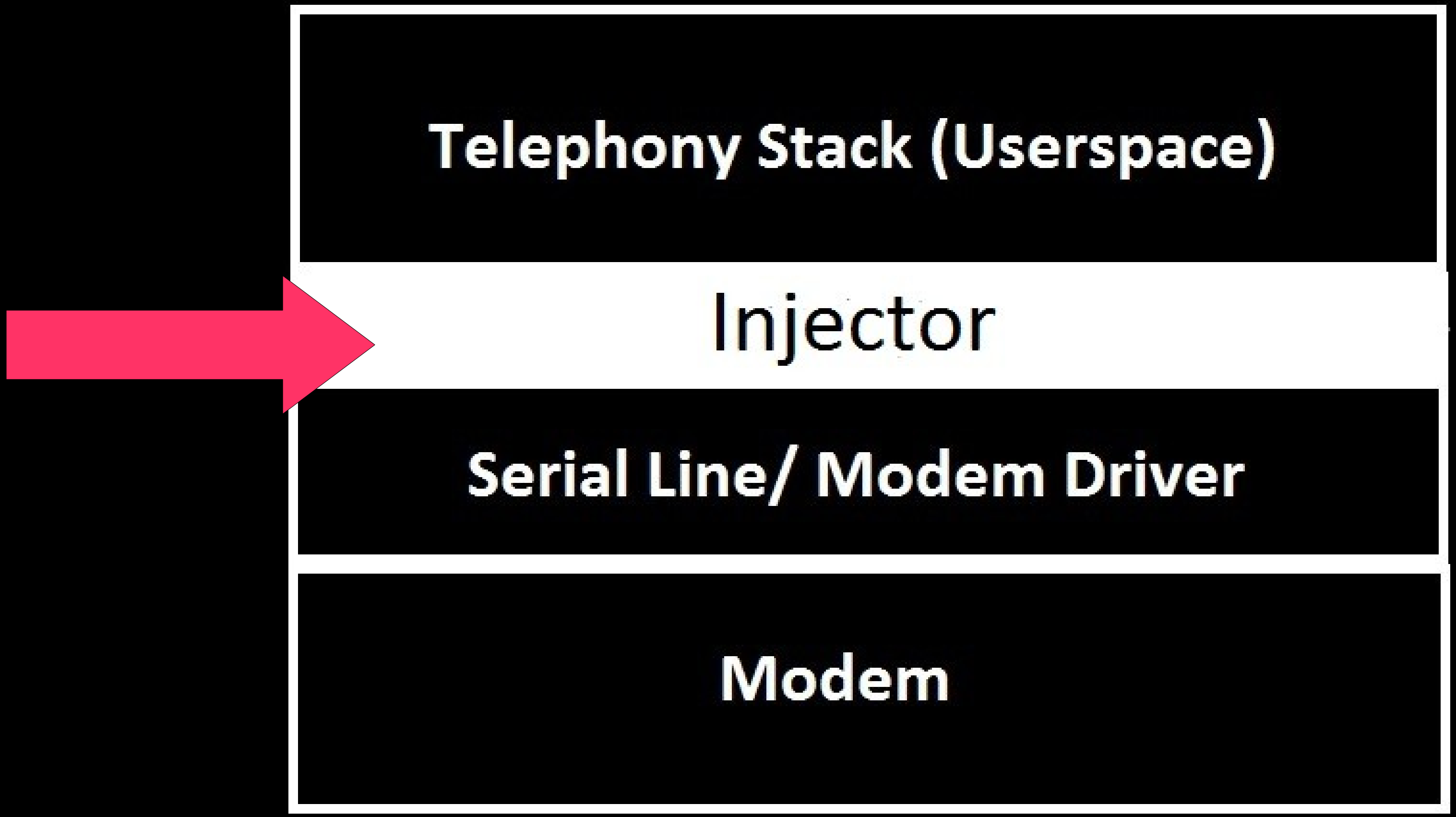

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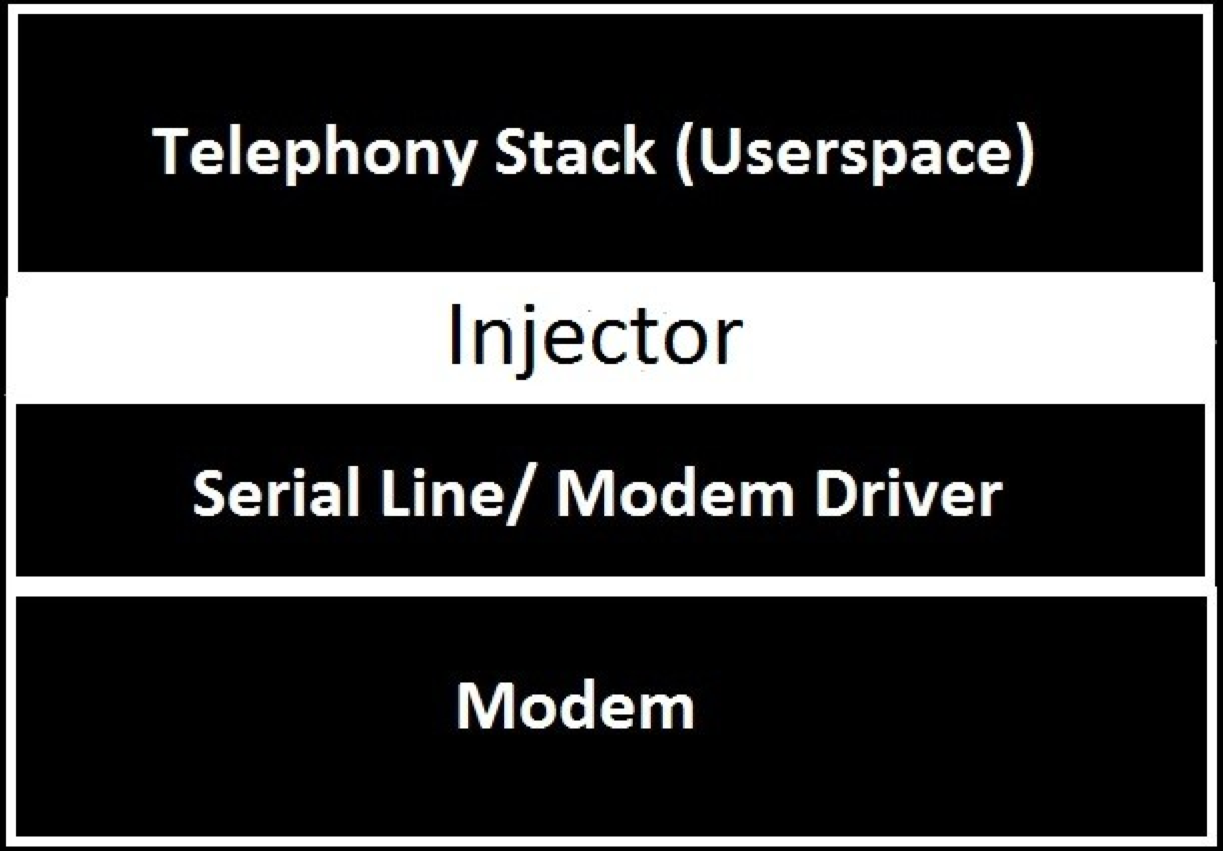
My Work: SMS Botnet C&C



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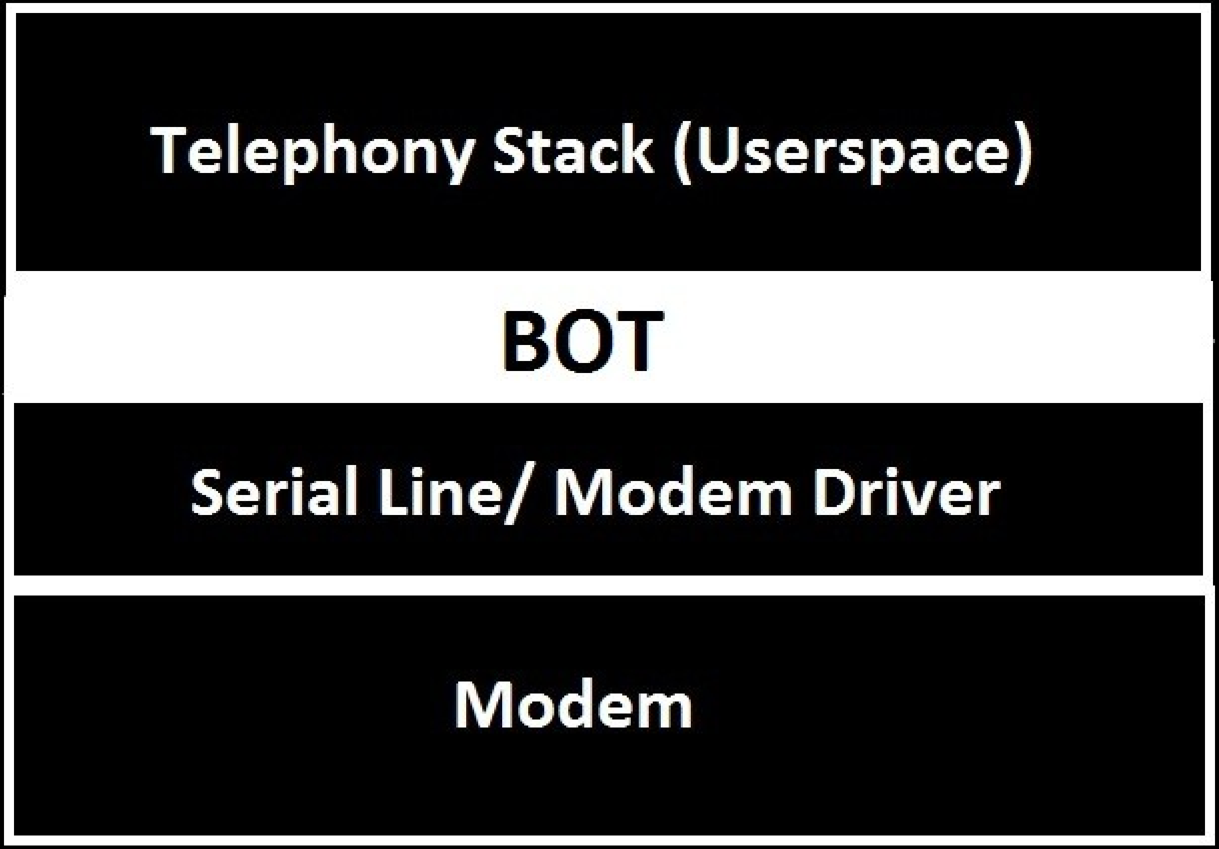

Telephony Stack (Userspace)

BOT

Serial Line/ Modem Driver

Modem

SMS-Deliver PDU

07914140540510F1040B916117345476F100000121037140
044A0AE8329BFD4697D9EC37

Field	Value
Length of SMSC	07
Type of Address (SMSC)	91
Service Center Address (SMSC)	41 40 54 05 10 F1
SMS Deliver Info	04
Length of Sender Number	0B
Type of Sender Number	91
Sender Number	51 17 34 45 88 F1
Protocol Identifier	00
Data Coding Scheme	00
Time Stamp	01 21 03 71 40 04 4A
User Data Length	0A
User Data	E8 32 9B FD 46 97 D9 EC 37

http://www.dreamfabric.com/sms/

SMS-Deliver PDU

07914140540510F1040B916117345476F100000121037140044A0A**E8329BFD4697D9EC37**

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Time Stamp	01 21 03 71 40 04 4A
User Data Length	0A
User Data	**E8 32 9B FD 46 97 D9 EC 37**

How the Botnet Works

1. Bot Receives Message

2. Bot Decodes User Data

3. Bot Checks for Bot Key

4. Bot Performs Payload Functionality

How It Works

1. Bot Receives Message

    Bot receives all communication from modem
    If SMS (code CMT) continue analysis
    If not SMS pass up to user space

2. Bot Decodes User Data

3. Bot Checks for Bot Key

4. Bot Performs Payload Functionality

How It Works

1. Bot Receives Message

2. Bot Decodes User Data

   Moves through PDU to User Data

   Decode 7 bit GSM to plaintext

3. Bot Checks for Bot Key

4. Bot Performs Payload Functionality

How It Works

1. Bot Receives Message

2. Bot Decodes User Data

3. Bot Checks for Bot Key
    Bot checks for secret key in message
    If bot message continue analysis and swallows message (user never sees it)
    If not bot message passed to user space
4. Bot Performs Payload Functionality

How It Works

1. Bot Receives Message

2. Bot Decodes User Data

3. Bot Checks for Bot Key

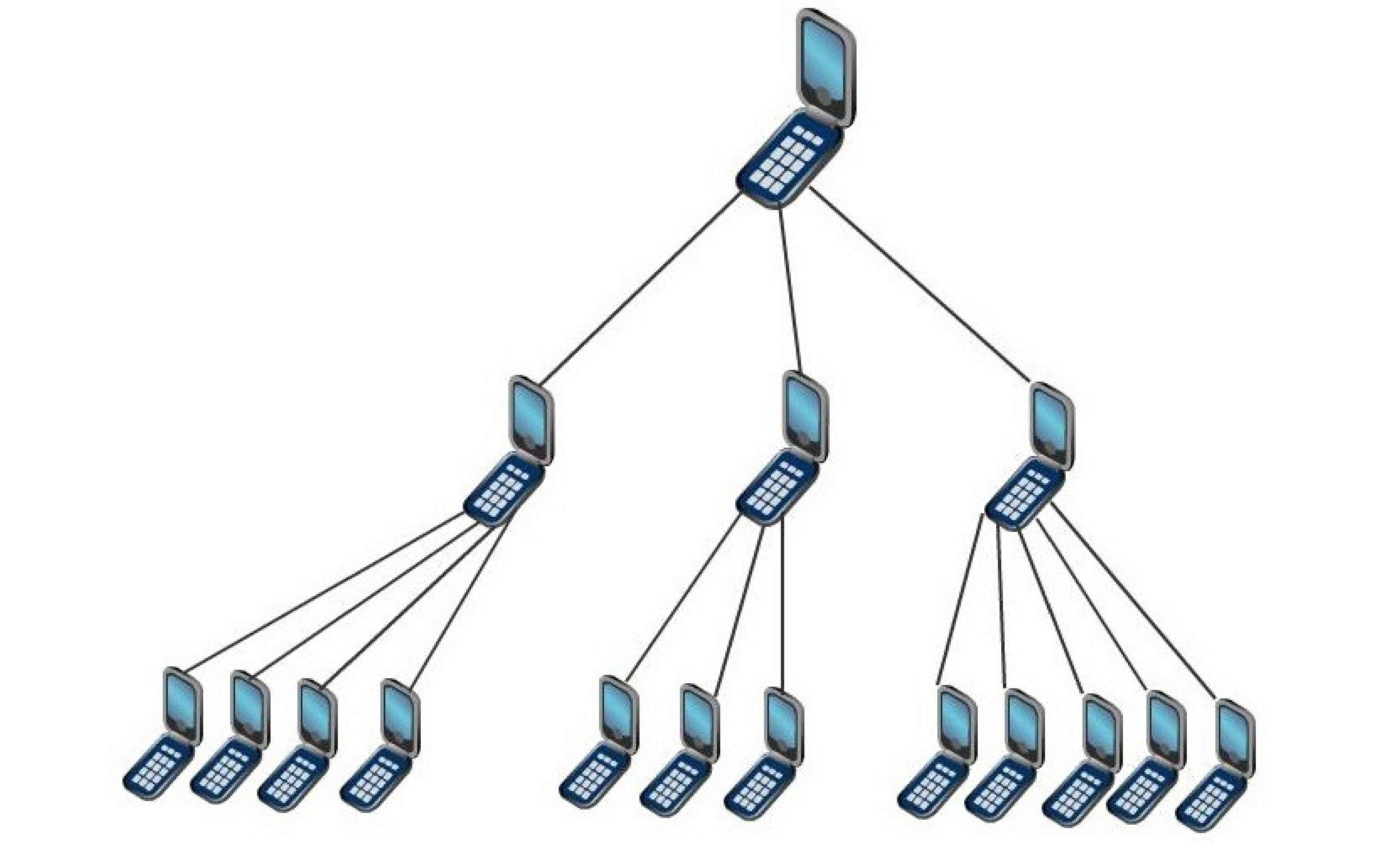
4. Bot Performs Payload Functionality

    Bot reads functionality request in message

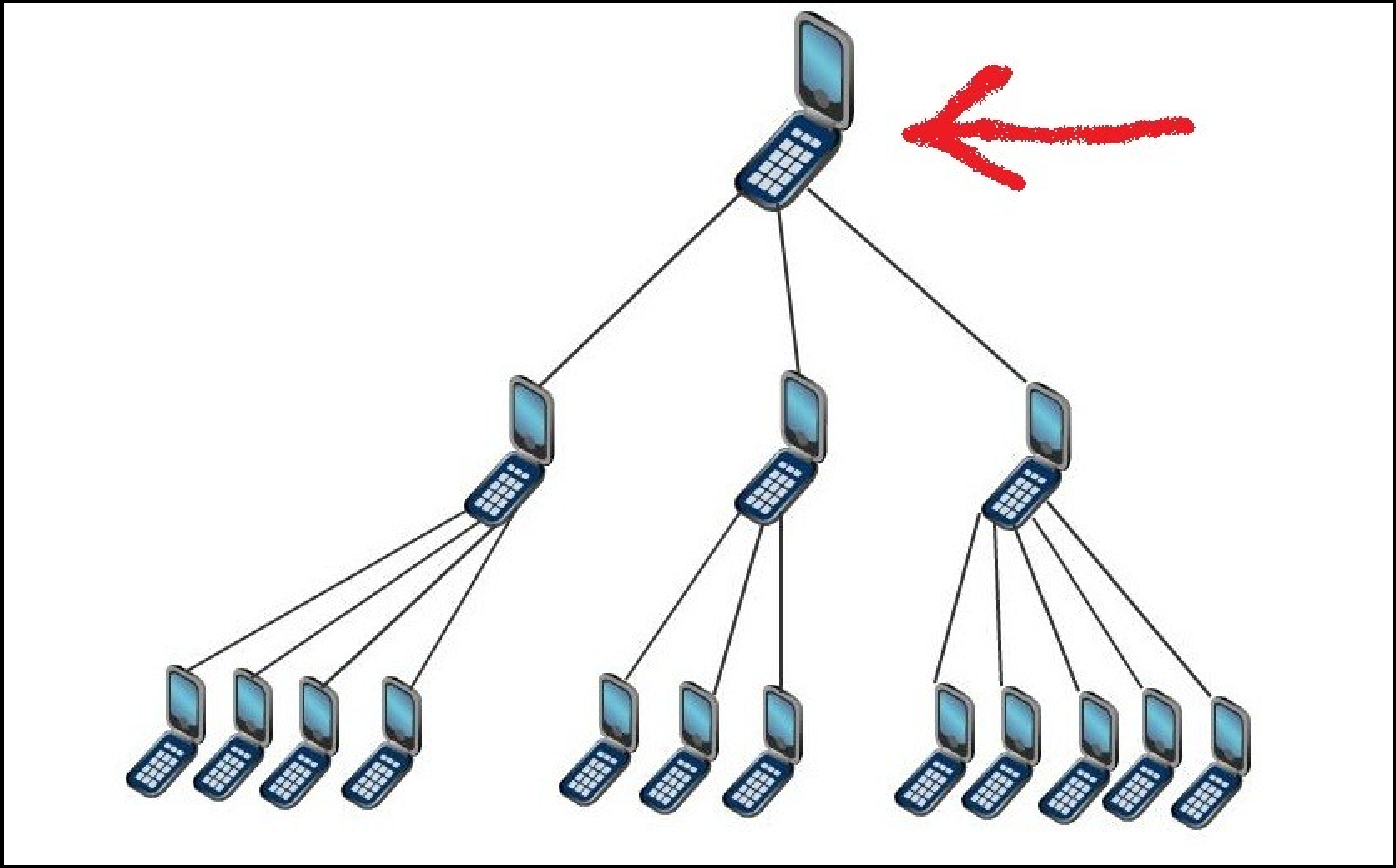
    If found perform functionality

    If not found fail silently

Botnet Structure



Master Bot



Master Bot

Handled by botherders

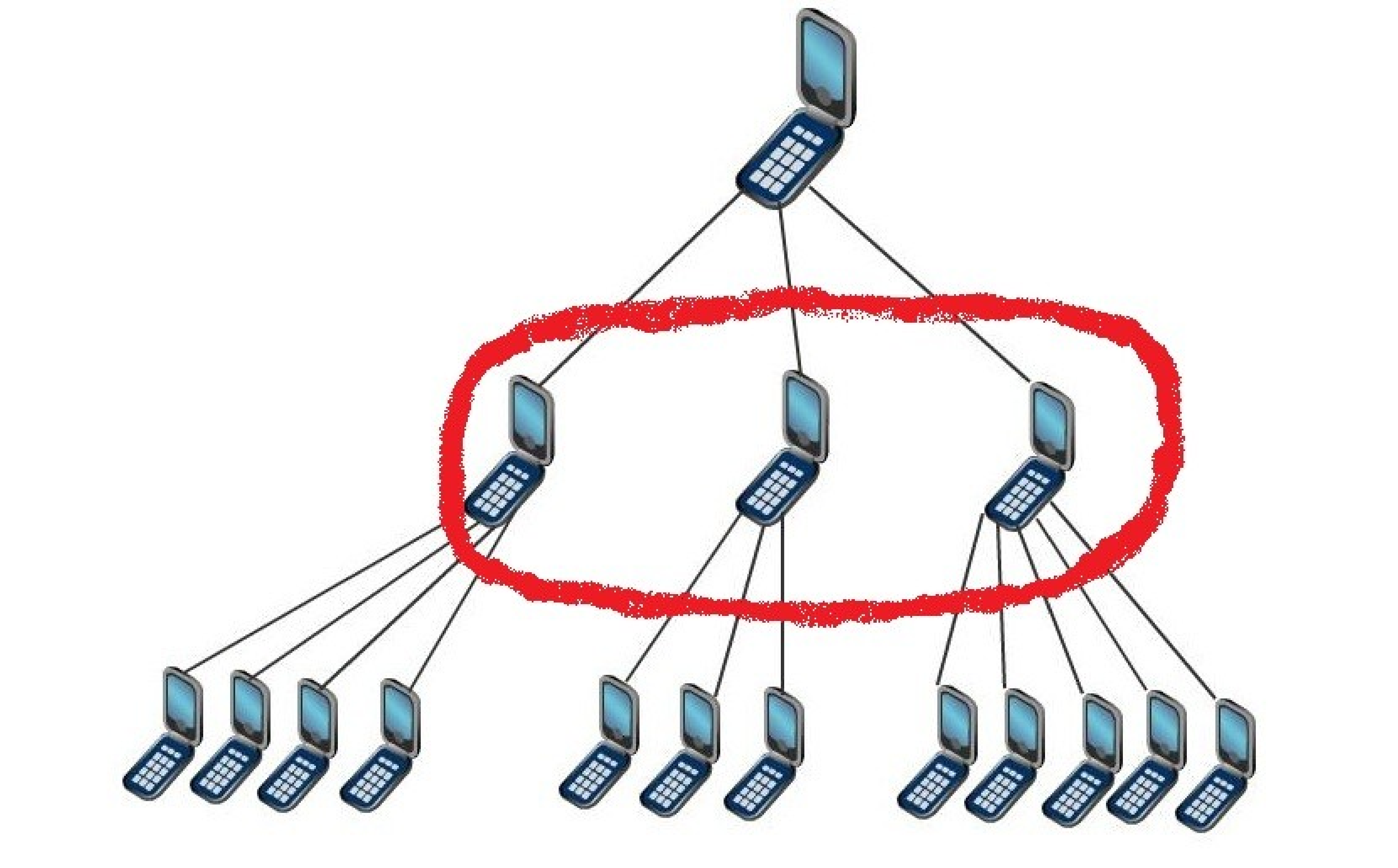
Switched out regularly to avoid detection

  Prepay SIM Cards + Kleptomania

In charge of bot structure

Sends instructions to Sentinel Bots

Sentinel Bots



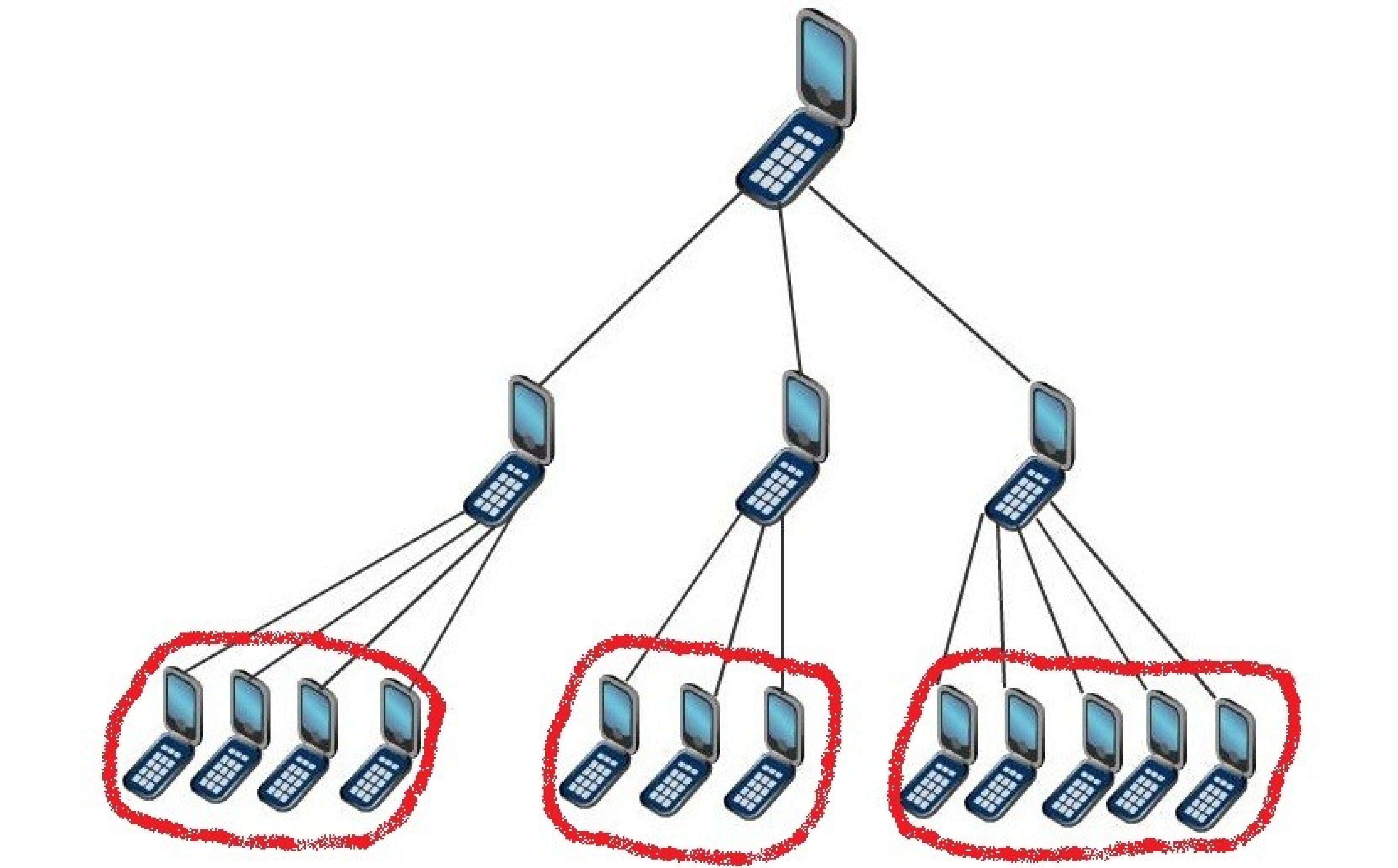
Sentinel Bots

Several “trustworthy” long infected bots

Receive instructions from master bot

Pass on instructions to a set of slave bots

Slave Bots



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Slave Bots

Receive instructions from sentinel bots

No direct contact with master bots

Carry out botnet payload functionality (DDOS, SPAM, etc.)

Robustness

Master Bot:

- May change device, platform, SIM at will
- Prepayed phones are difficult to track
- Has knowledge of all active bots

Sentinel Bots:

- Reserved for long time bots
- The only bots that interact directly with the master
- Master may promote any slave when needed

Slave Bots:

- A compromise results in at most finding the identity of a single sentinel

Security Concerns

Impersonation:

- Use cryptographic keys to authenticate master bot and sentinel bots

Replay:

- SMS timestamps
- Sequence numbers/ one time keys

Elliptic Curve Algorithm

Limitations

Possibility of detection from phone bills

User Data is limited to 160 characters (instructions and keys must fit in this space)

On some platforms only the modem knows the phone number

Getting The Bot Installed

Regular Users:

- App + Local Root Exploit (Sendpage etc.)
- Example: John Oberheide's Twilight
- Android Botnet Defcon Skytalks 2010

Root-level/Jailbroken Users:

- Root level app using proxy function for AWESOME + Bot
- Example: flashlight + tether for iPhone

Remote:

- Remote root exploit (rooted and nonrooted)
- Example: iKee-B “Duh” Worm for iPhone

Example Payloads

- Spam
  - Creating SMS-Send PDUs and passing them to the modem
  - Example: SMS ads
- DDOS
  - Millions of smartphones vs. a server
- Loading New Functionality
  - Send URL in payload
  - Download the module into known payloads
- Degrading GSM service
  - Overloading the network with bogus requests

What This Really Means

If attackers can get the bot installed they can remotely control a user's phone without giving any sign of compromise to the user.

Mitigation

Integrity checks of base smartphone operating systems

Liability for smartphone applications including root level

User awareness

Parallel Research:

Rise of the iBots: Owning a Telco Network
Collin Mulliner and Jean-Pierre Seifert

SMS/P2P hybrid smartphone botnet research

iPhone based

http://mulliner.org/collin/academic/publications/ibots_malware10_mulliner_seifert.pdf

DEMO :)

Android Bot with SMS Spam Payload

Released code has the bot without payloads (have fun)

Thanks

To Mom for helping me master stuff like this:

```
char* encodedmessage;
encodedmessage = malloc(13);
encodedmessage = hellogeorgia;
```

Contact

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Website: http://www.grmn00bs.com
Twitter: vincentkadmon

Slides and Code are on the website

Selected Bibliography

SMS fuzzing: http://www.blackhat.com/presentations/bh-usa-09/MILLER/BHUSA09-Miller-FuzzingPhone-PAPER.pdf

Cell bots attack GSM core: http://www.patrickmcdaniel.org/pubs/ccs09b.pdf

Twilight botnet: http://jon.oberheide.org/files/summercon10-androidhax-jonoberheide.pdf

SMS/P2P iPhone bots: http://mulliner.org/collin/academic/publications/ibots_malware10_mulliner_seifert.pdf

False Starts: User Header Data

User Header Data (UHD) is just ahead of User Data in a PDU

Tells the phone how to handle the SMS (ex. Concatenated message)

Previous security research found faws in how these are handled resulting in compromises

False Starts: User Header Data

Not all UHD codes are used

Planned to use unused codes for bot instruction indicators

This worked fine with fuzzers and emulators

SMSCs drop PDUs with unused codes. UHD based bots are not usable in the wild

Some used codes are also dropped