Zero Fax Given

@zeronights - 2018

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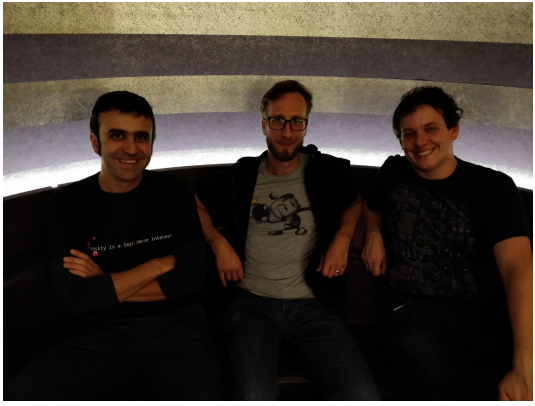
2018

X41 D-SEC GmbH

whoarewe

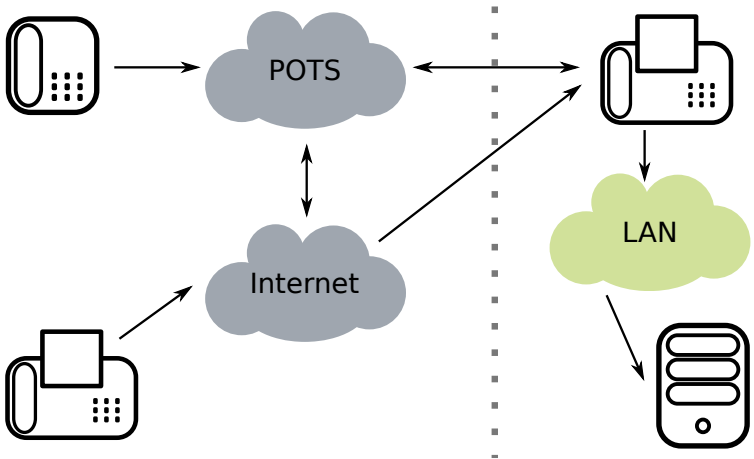


Luis, Eric, Markus

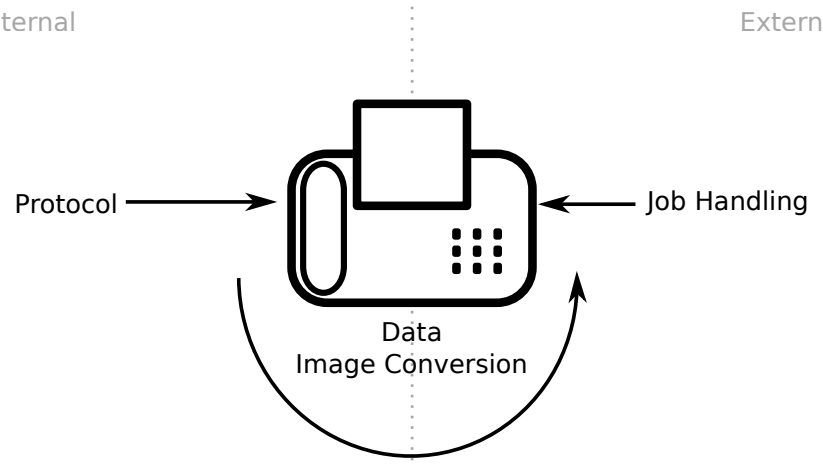
Motivation

- Fax machines still present in private and public spaces
- Its technology matured decades ago and might not get much love since then
- All-in-one usually connected to phone and ethernet networks
- Usually not considered as an attack vector

Attack Surface - Global



Attack Surface - Local



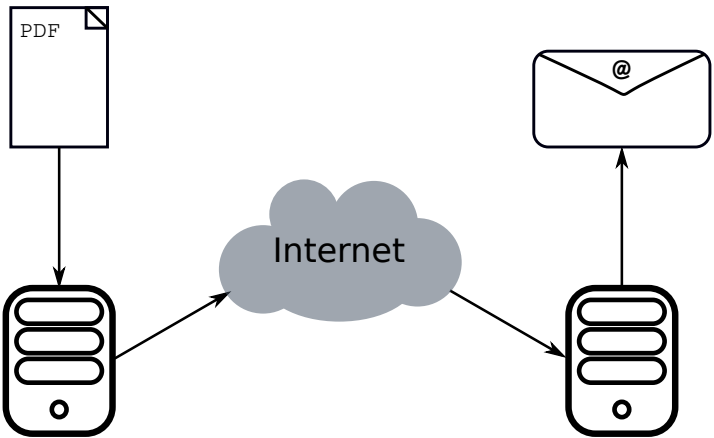
Fax Protocol

- Specified in ITU recommendations
- Analog (mostly obsolete):
  - Group 1 / Group 2, similar to Analog-TV transmission (hello scanlines..)
- Digital: <= **we looked at this**
  - Group 3 / Group 4
  - Supports compression, TIFF / JPEG
- The Fax Class specifies what is offloaded to the actual fax modem hardware

Internet Fax

- Fax protocols were originally designed to go over telephone lines
- VoIP is killing them due to variances in latency and high-compression encoding omitting signals
- T.38 was developed to counter this

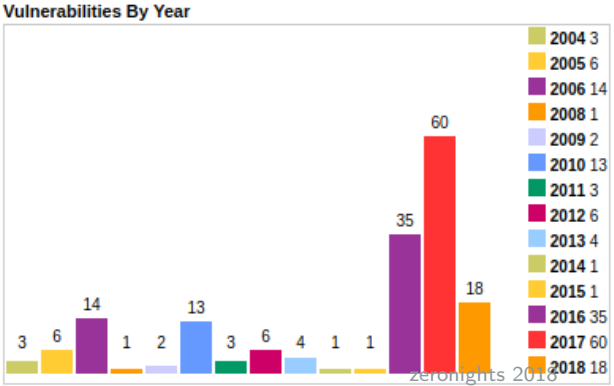
Internet Fax - Additional Attack Surface

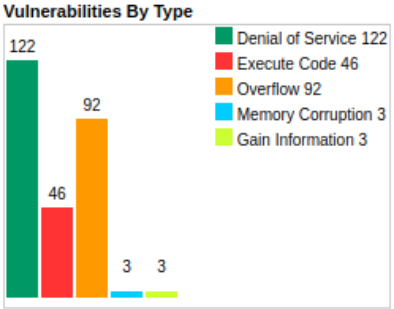


Compression

- T.4 Recommendation specifies just Modified Huffman (MH) and Modified READ compression
- T.30 added JBIG, JPEG, and MRC as compression, even supporting color
- *In other words: a lot of parsers and complex formats, great!*

Compression Libraries and Known Vulnerabilities - Fun With libtiff





Fax Security Features That You Encounter

- *NO* Encryption
- *NO* Integrity
- *Yet, it seems to be somewhat reliable (you can be quite confident a fax was received.)*
- A fax is officially accepted in many countries by courts as a reliable way of transmitting documents

Encrypted Fax Anyone?

Annex H

Security in facsimile G3 based on the RSA algorithm

H.1 Preamble

(The preamble is left blank on purpose.)

WANTED

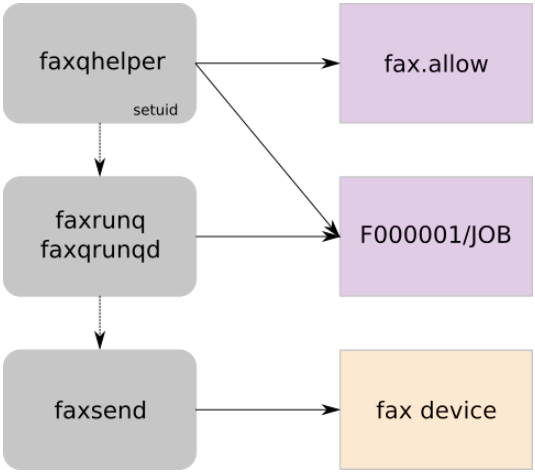
H.2 Introduction

This annex specifies the mechanisms to offer security features based on the RSA cryptographic mechanism. The coding scheme of the document transmitted with security features may be of any kind defined in Recommendations T.4 and T.30 (Modified Huffman, MR, MMR, Character mode as defined in Annex D/T.4, BFT, other file transfer mode defined in Annex C/T.4).

mgetty

mgetty is a modem-aware getty. It supports modems with the Hayes AT command set and is especially designed for supporting modems that are used to send faxes and to dial out as well as dial in.

mgetty flow


faxqhelper
setuid
fax.allow
faxrunq
faxqrunqd
F000001/JOB
faxsend
fax device

mgetty - faxqhelper

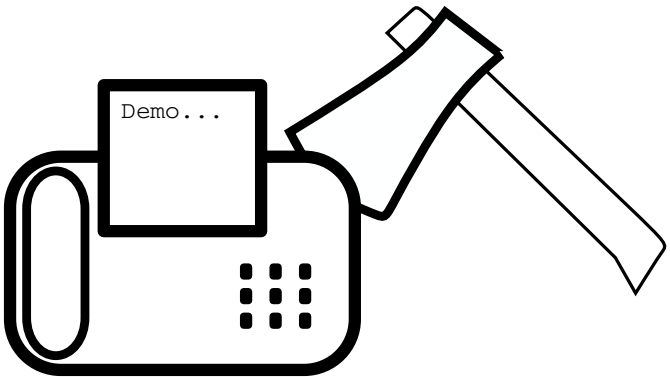
```
/* replace all quote characters, backslash and ';' by '_' */
for( q = buf; *q != '\0'; q++ )
{
  if ( *q == '\'' || *q == '"' || *q == '`' ||
       *q == '\\' || *q == ';' )
                    { *q = '_'; }
}
```

mgetty - faxrunq

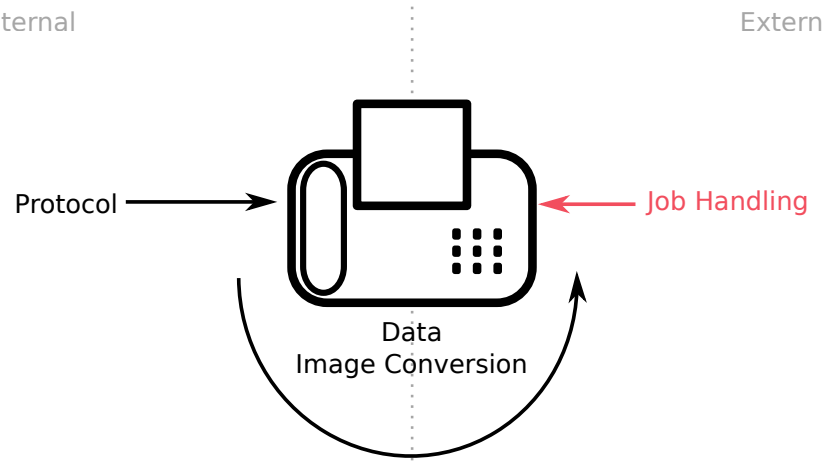
```
  /* replace all quote characters, backslash and ';' by '_' */
  command=`tr -d '\042\047\140\134\044\073' <JOB | \
    $AWK 'BEGIN { phone="-"; flags=""; pages="" }
      $1=="phone" { phone=$2 }
      $1=="pages" { for( i=2; i<=NF; i++) pages=pages$i" " }
      END { printf "'"$FAX_SENDER"' -v%s %s %s", \
        flags, phone, pages }' -`

# execute faxsend command
    eval $command
```

DEMO - mgetty



Attack Surface



efax

efax is smaller and easier to install than HylaFAX or mgetty+sendfax. As one user put it "EFAX is a nice simple program for single user systems."

efax - Coverage

- Several bugs found
- Only lightly explored
- Should not be used where security is relevant

efax - efix

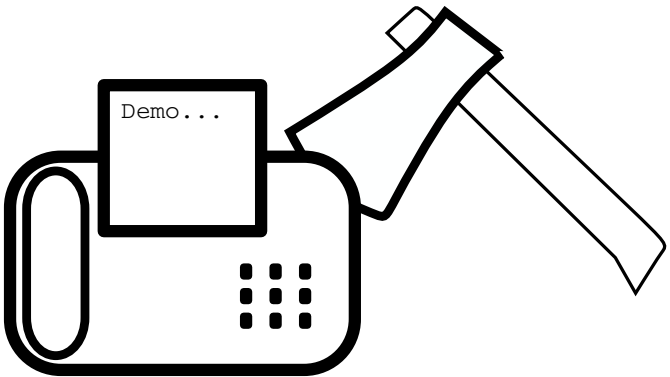
```
int readline ( IFILE *f, short *runs, int *pels )
{
  int nr = 0, nb ;
  uchar bits [ MAXBITS ] ;

    case P_PBM:
      if ( fread ( bits, 1, f->page->w/8, f->f ) !=
        ↪  f->page->w/8 )
```

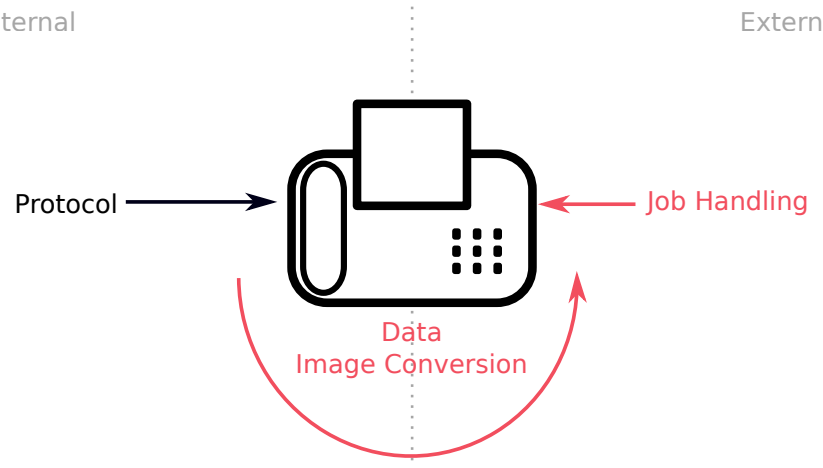
efax - efix

- Just a stack based buffer overflow...
- What about ASAN?
- Debian Stable / gcc 6.3.0 20170516
- ***fread()*** not checked

DEMO - efix



Attack Surface



Fingerprinting I

```
> ATD10000
< CONNECT
< HylaFAX (tm) Version 6.0.6
```

Fingerprinting II

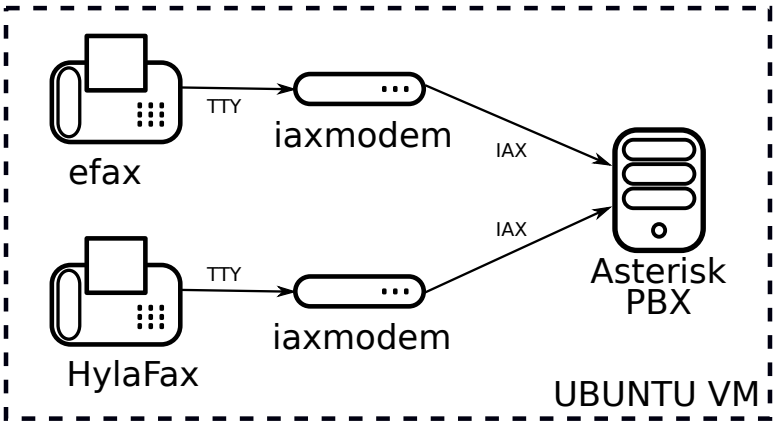
Devices announce their capabilities

- Compression
- Resolution
- Transmission Rate
- Error Correction
- JBIG and JPEG

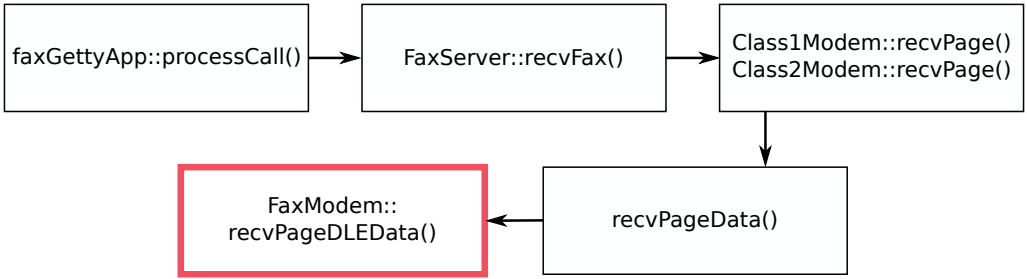
HylaFAX

HylaFAX Open Source is designed around a client-server architecture. Fax modems may reside on a single machine on a network and clients can submit an outbound job from any other machine on the network. Client software is designed to be lightweight and easy to port.

HylaFax Setup



HylaFax - Callchain



faxgetty - Heap Overflow While Fax Reception

```
// FaxModem::recvPageDLEData(...) excerpt
recvRow = (u_char*) malloc(1024*1000); // 1M should do it?
do {
  // ...buf is filled with contents from calling party...
  // ...fin=true; when receiving EOF or timing out...
  memcpy(recvRow, (const char*) buf, cc);
  recvRow += cc;
} while (!fin);
```

faxgetty - Heap Overflow? Are you sure?

By messing with format flags during a call, *recvRow* could:

- remain uninitialized
- point to a heap buffer
- point to a stack buffer
- offset it before triggering mempy

faxgetty - Unitialized Pointer

DEMO - Step Through The Code

faxgetty - Unitialized Pointer - Exploitation

1. Hit a code path that makes it point to something interesting (Heap or Stack)
2. Hit a code path where this will be allocated to another object
3. Hit a code path that allows you to write into the newly allocated object

faxgetty - Unitialized Pointer - Exploitation

DEMO - Showing the Code Paths

faxgetty - Unitialized Pointer - Problems

DEMO - MMAP is not our friend

faxgetty - Unitialized Pointer - Problems

DEMO - Exploiting it by Pointing to the Stack

faxgetty - Unitialized Pointer - PoC

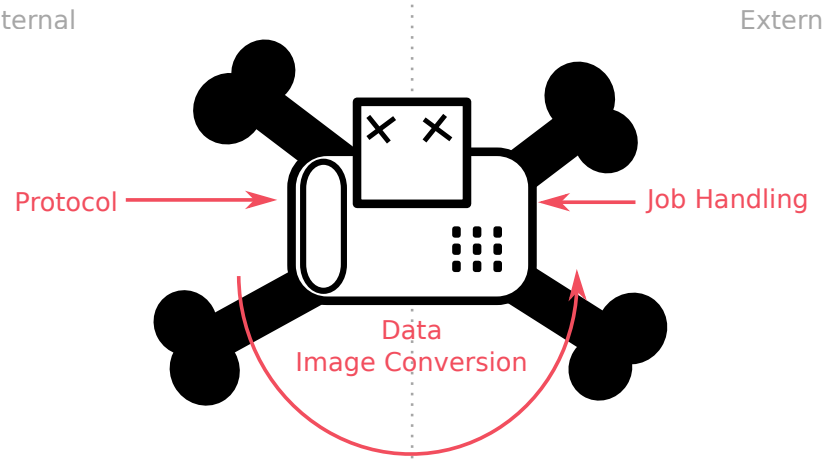
How to get control flow:

1. Submit a TIFF Using DLE Transmission → will point *recvBuf* to the stack
2. Submit a ECM transmission setting JPEG + 2DMR flags
3. Profit

faxgetty - Unitialized Pointer - PoC Demo

DEMO - Exploiting it by Pointing to the Stack

Killed


Internal
External
Protocol
Job Handling
Data
Image Conversion

Conclusions

- Use different compilers, hardening and optimization settings during fuzzing
- Revisit old technology, do not simply follow the new hype train

Q & A - Thanks for listening!

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