IrCOMM2k

Porting Linux IrDA to the Windows Kernel

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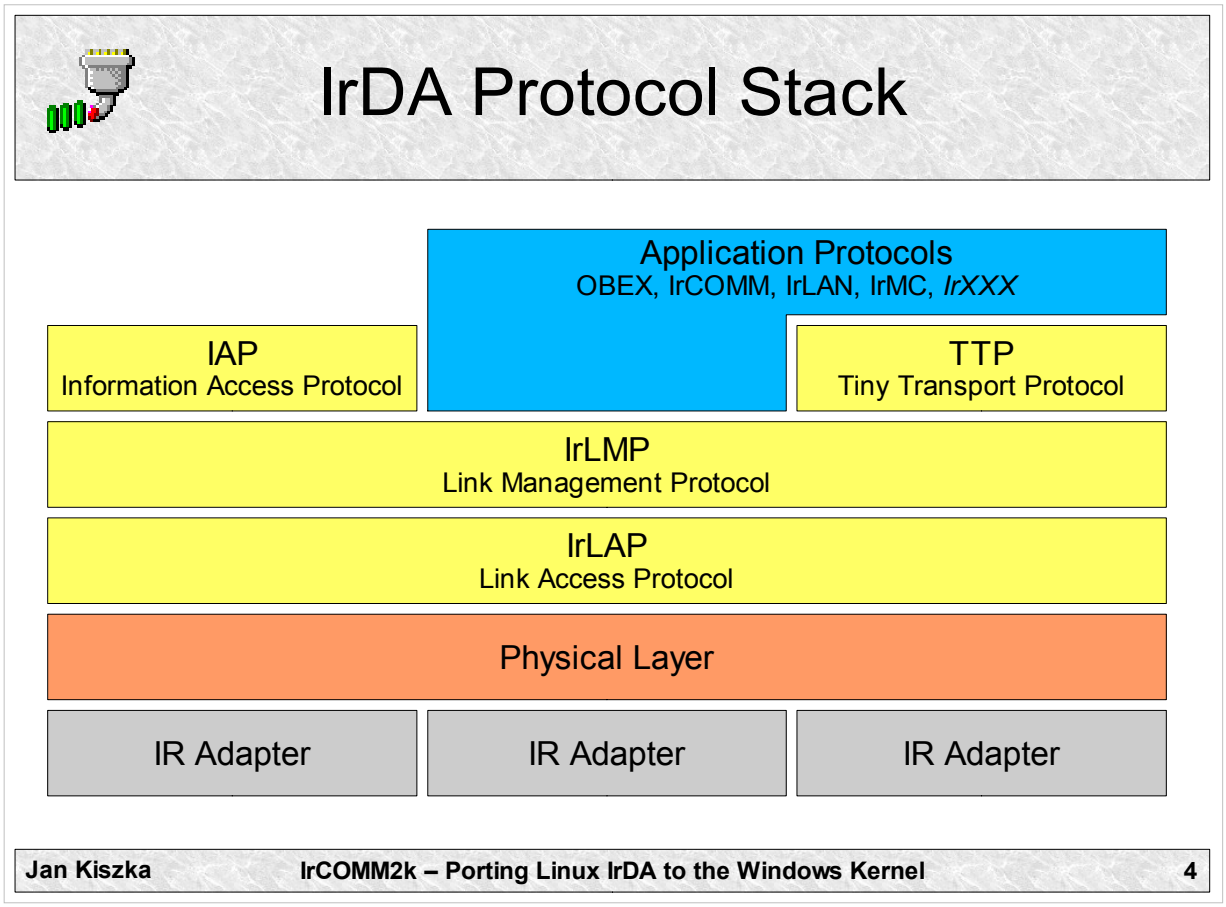
Overview

- IrDA Introduction
- Motivation: IrCOMM on Windows
- Architectures
- Analysis and Visualization
- Project Status
- Synergy Effects
- New Project Proposal
- Conclusion

IrDA

- Specification about how to exchange data using infrared beams
- Widely available: cell phones, PDAs, notebooks, PC adapters
- Half-duplex, serial, point to point transmission
- Typical baud rates from 9,6 Kbit/s up to 4 Mbit/s
- Why still IrDA when there is Bluetooth, etc.?
  - Hardware is lower cost and more common
  - Faster than Bluetooth (4 MBits/ vs. 1 MBit/s)
  - Intuitive user interface (point and shoot)
  - Security advantages: physically constrained link
  - No electromagnetic interference (802.11, cordless-phones, microwave oven, etc.)

- Infrared Data Association: industry group of more than 100 hardware and software vendors
- Baud rates:
  - 9,6 Kbit/s - discovery and link setup
  - 115 Kbit/s - RS232 IR adapters, small devices
  - 4 Mbit/s - USB adapters, notebooks
  - [16 Mbits/s - specified, but no hardware available]



- Physical Layer:
  - Interface between optical and electrical medium
  - Modulation
- IrLAP:
  - Frame wrapping
  - Link access control (master/slave-based when connected)
  - Device and link addressing
  - Discovery
  - Link (point-to-point) establishment with capability negotiation (baud rate, timing, frame size)
  - Error detection and frame repetition
  - Low level flow control
- IrLMP:
  - Service multiplexing over established links
  - Includes IAS
- IAP:
  - Used by Information Access Service (IAS)
  - Provides or retrieves information about available IrDA application protocols (service addresses, parameters)
- TTP:
  - flow control at service level
  - segmentation and reassembly
- OBEX: Exchanges files, phone book entries, etc.
- IrCOMM: Replacement of wired RS232 and Centronics
- IrLAN: LAN over infrared
- IrMC: Telephone specific services (phone book, calendar, messaging, voice, ...)
- IrXXX: Implement your own protocols (just like on top of TCP/IP)

IrDA Status

	Linux	Windows 2000/XP
Drivers	+	++
Basic Stack	+...++	(+)
OBEX	✔	✔
IrLAN	✔	n/a
IrNET (not IrDA)	✔	✔
IrCOMM	+...++	poor

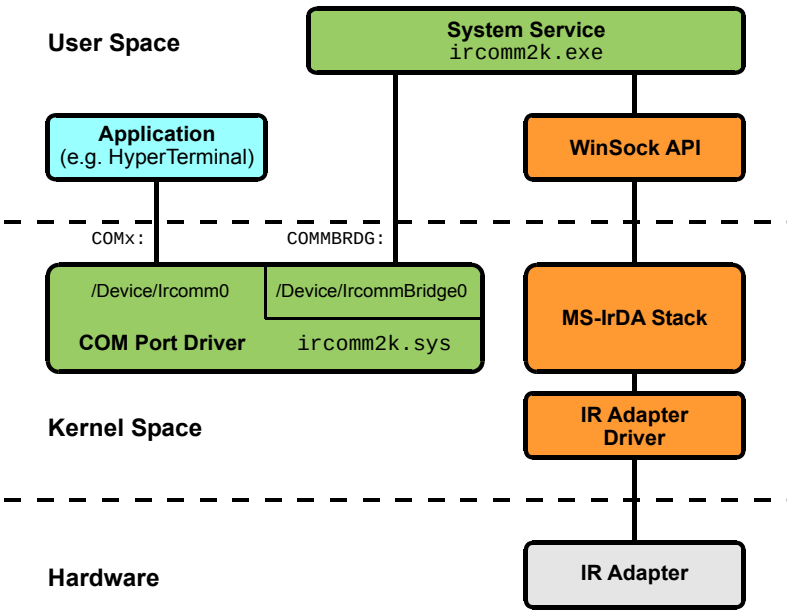
- Drivers:
  - Linux support is constantly getting better (today less new IR chipsets)
- Basic Stack:
  - Linux stack very mature (e.g., it does not hang), memory leaks now fixed
  - Windows stack can hang in certain error situations, this could also be caused by user mode tools (which are definitely faulty)
- IrLAN:
  - Microsoft introduced IrNET (PPP-based) as a replacement of IrLAN (IR-to-Ethernet)
- IrCOMM:
  - Centronics support missing on Linux (minor importance)
  - And on Windows...?

The IrCOMM Issue

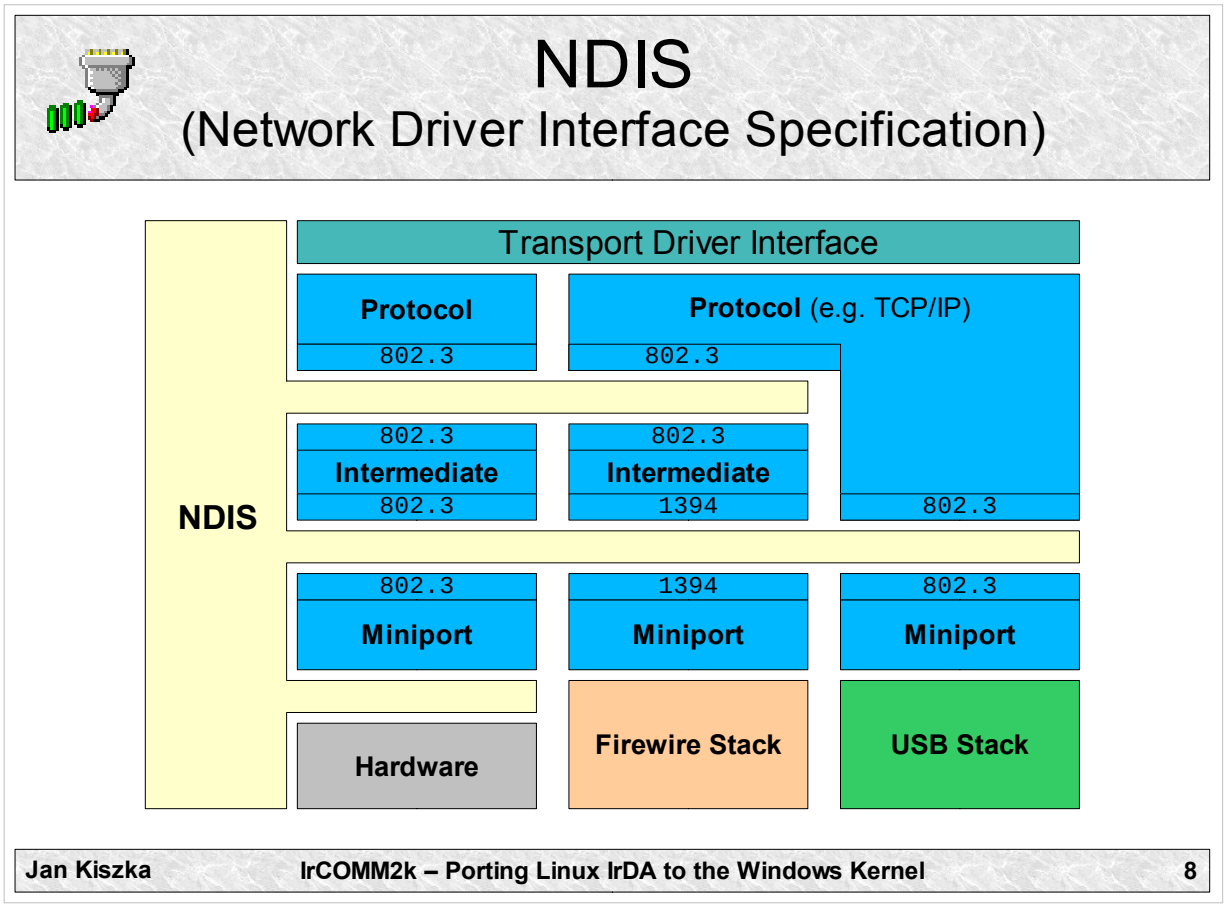
- Worked well with Windows 9x/ME
- NT4: no IrDA at all (commercial solution available)
- Minimal support on first Win2k version
  - No virtual COM port
  - Software should use socket API instead
  - ➔ No cell phone modem support
  - ➔ Hardly no PDA synchronization
  - ➔ No control parameters (status lines, etc.)
- Win2k Service Pack 2 / WinXP
  - Cell phone modem support
  - Hidden virtual COM port
    (badly implemented, cell phones only)

- Microsoft wanted software vendors to modify their programs, which didn't worked as expected:
  - Palm updated HotSync correctly
  - Nokia bought third-party virtual COM port solution (very faulty)
  - Many cell phone or sync tools never got updated
- End of 2000: First contact with IrDA on an internship (implemented simple IrDA/IrCOMM stack for 68K handheld)
- IrCOMM started as a free time project (I always wanted to write a Windows driver :-))
- First release 03/2001

IrCOMM2k Version 1



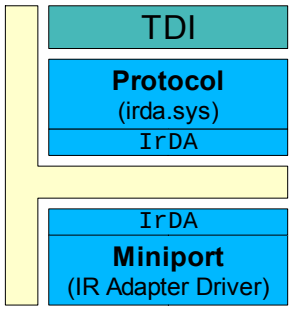
- Straight forward approach: Use what Microsoft gave us (socket API for IrCOMM)
- Requires to disable built-in IrTRAN-P (picture transfer for digital cameras) support for incoming connections, which does not always work immediately
- Incoming status lines (CTS, DSR, RI, and DCD) can be statically set or cleared on virtual COM port
- It was a progress, but many programs still refused to work (PsiWin, cell phone tools, ...)



- Framework supporting structured development of interface drivers, filters, media translators, and protocols
- Defines set of available media types for upper and lower edges of drivers
- Specifies functionalities, which drivers have to provide
  - Packet handling
  - Miniport configuration objects (OIDs)
  - PnP and power management
- Provides library to access hardware, system resources, and other NDIS drivers
- Some strange limitations on miniport drivers (cannot easily access all kernel features), protocol drivers do not suffer from it
- Allows to control the binding order (user mode hook functions called during setup procedure)

NDIS and IrDA

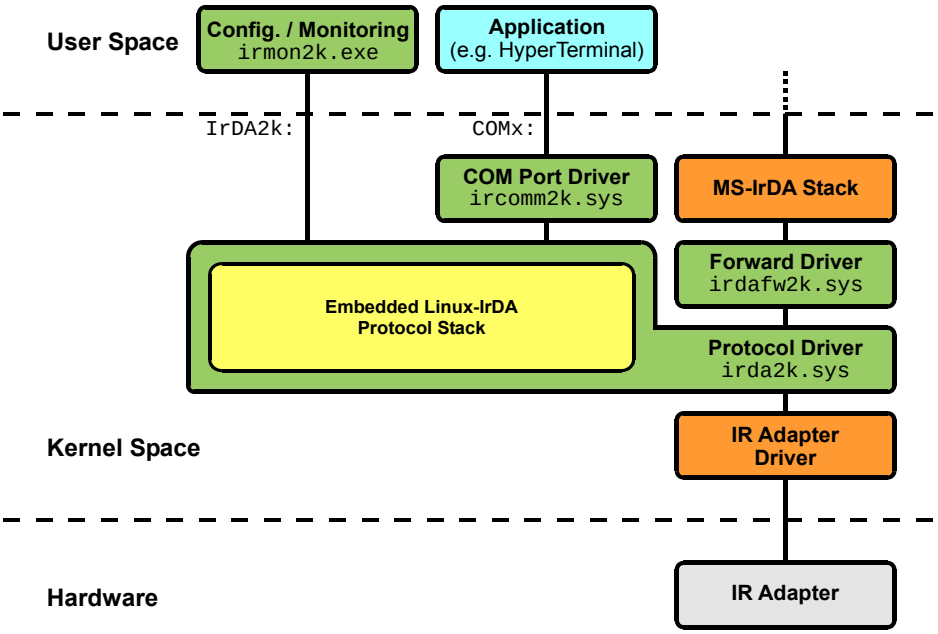
- Additional NDIS medium “IrDA”
- Simple and well specified driver interface



How to improve IrCOMM support?

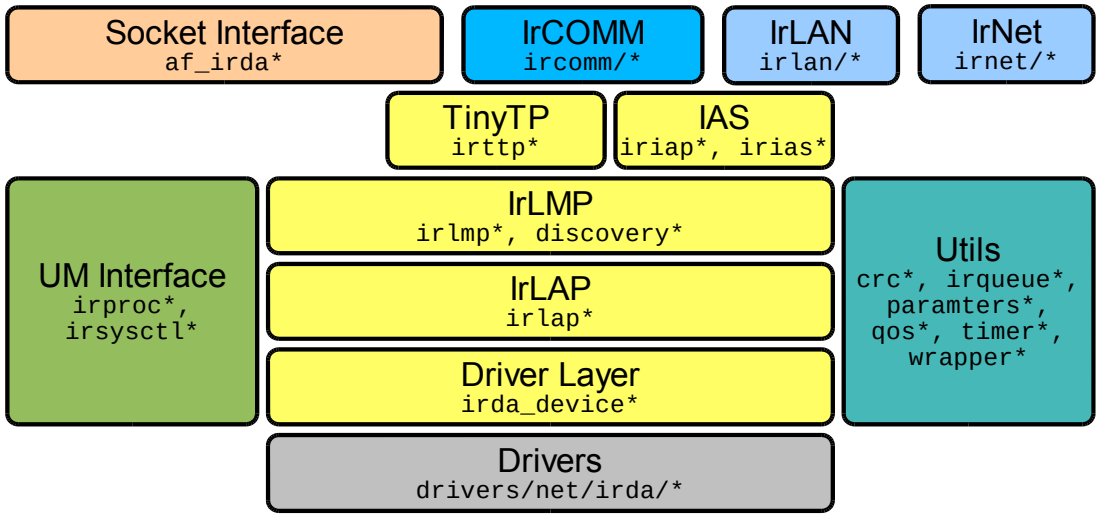
- Idea 1: Attach at TDI level
  - ➔ TDI details for IrDA not published
- Idea 2: Intermediate IrDA driver (filter)
  - ➔ Does not work with IrDA medium
  - ➔ But: Registration of parallel IrDA protocol driver possible
  - ➔ Manipulation of the binding order required
  - ➔ Full “shadow” IrDA stack is needed!

IrCOMM2k Version 2



- NDIS binding manipulation:
  - MS-IrDA only binds to forward devices
  - IrDA2k only binds to real adapter devices
- One forward adapter per real IR adapter
- Several COM ports supported (shortcoming of the first version)
- Switching between IrDA2k and MS-IrDA:
  - Manually (using task bar menu of irmon2k)
  - Automatically: Cut off MS-IrDA as soon as a virtual COM port is opened, but try to send disconnect request/command first if MS-IrDA was connected

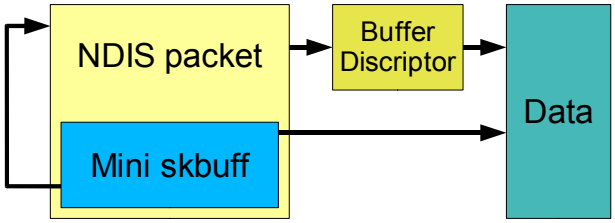
Components of Linux-IrDA



- Very well structured
- Almost a 1:1 implementation of the specification (especially state machines)
- Required for IrCOMM2k:
  - IrCOMM (without tty implementation)
  - Core layers (TinyTP, IAS, IrLMP, IrLAP)
  - Driver layer (requires adaption)
  - Most utils (without driver related crc* and wrapper*)

Porting the Driver Layer

- Common functionality:
  - Send / receive IrLAP payload data (no wrapping)
  - Report media busy
  - Set baud rate
  - Get adapter parameters (baud rates, timing, etc.)
- Payload encapsulation
  - Linux: skbuffs
  - Windows: NDIS packets
  - Mini skbuff inside private packet field
  - No fragmentation (not used by Linux-IrDA)
  - Every NDIS-IrDA packet must carry QoS parameters



- skbuffs:
  - Generic packet administration structure
  - Contains addresses and data pointers
  - Data can be fragmented
- NDIS Packets:
  - Equivalent on Windows (very similar)
  - Can include an additional private field
  - Preallocated pool required (can be extensible)
- Mini skbuff contains only needed fields for IrDA

Making Linux-IrDA Compile

- Provide new kernel header files
- Mappings
  - Memory allocation (size must be stored with every block!)
  - Spin locks (simple)
  - Timers (requires patches)
  - Work queues (mapped to a single semaphore)
- New message macros (IRDA_DEBUG etc.)
- Some additional fiddling
  - Many void #defines (__init, __attribute__, ...)
  - Very few patches (e.g., “#pragma pack” avoids structure alignment)
- Managed the include dependencies (hard work)

- Maxim: Modify the Linux-IrDA source code as less as possible
  - ➔Easier updates to new kernel versions
- Timeouts: relative on Windows, absolute on Linux
  - ➔Remove “jiffies” from timeout calculations
- Work queues: only used for soft-IRQs of virtual IrCOMM ports (transmission complete, flow control events)
- Message macros (was a bit tricky):
  - VC++ does not support variable argument lists in macros!
  - Inline functions required
  - __FUNCTION__ not known to VC++, provides __FILE__ and __LINE__ instead
  - __LINE__ is an integer, cannot be concatenated to strings by the preprocessor (very annoying)
  - Do not want to modify every IRDA_DEBUG, map __FUNCTION__ to __FILE__
- Include dependencies:
  - Some kernel header files must include DDK headers, correct order is important
  - First ran into some circular dependencies
  - Include tree is not beautiful, but it compiles

Compiled Linux-IrDA!

- First test as a console application (irdalnx)
  - built-in ACTiSYS dongle driver
  - used old virtual COM port (ircomm2k.exe substitution)
- Finally integrated into irda2k.sys – **and it worked!**

- IrCOMM2k 2.0.0 enabled the first IR-based synchronization between PSION handheld and Windows 2000/XP
- All known cell phone tools work without problems (e.g. PEP2000, s25@once, Mobile Master, VisSie)
- First IrLPT server on Windows 2000 was implemented using IrCOMM2k 2.0.0 (captures printing of a mobile medical device)

Analyzing IrCOMM2k

- What to do with all the printks of Linux-IrDA?
  How to debug IrDA traffic, locally and on remote systems?
- Solution: new device for both debug messages and IrDA packets
- Simple console application (irda2kdump) prints messages and raw packets preserving the context
- Redirection to file enables simple remote diagnosis

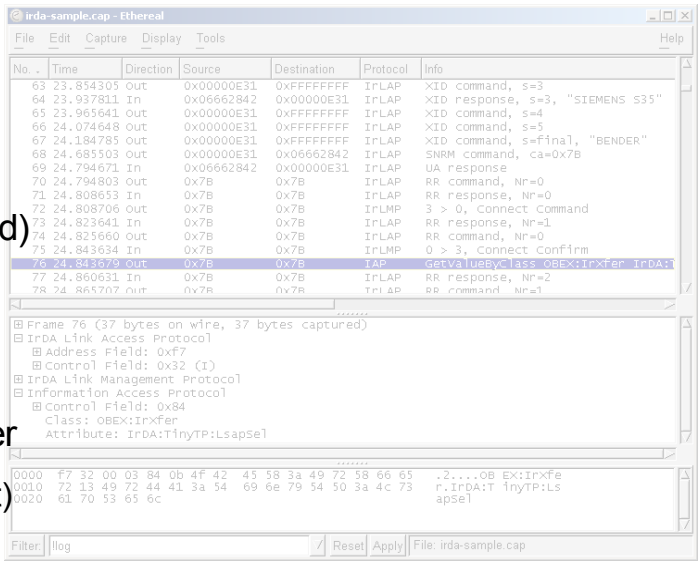
```
219 (0.000155): d:\projekte\...\irttp.c() send=1,avail=1,remote=14
220 (0.000172): d:\projekte\...\irlap_event.c() : queue len = 1
221 (0.000101): <== E1 B0 17 1D 00 00 16 10 02 35 00 01 04 01 00 10 03 F5 C8
                    á  °                    5                    õ  È
222 (0.000222): d:\projekte\...\irttp.c() : send_credit = 1, queue_len = 0
223 (0.011385): ==> E0 2A 1D 17 00 00 16 10 02 33 00 01 04 01 00 10 03 78 29
                    à  *                    3                    x  )
224 (0.000129): d:\projekte\...\irttp.c() send=1,avail=2,remote=13
225 (0.000769): d:\projekte\...\ircomm_tty_attach.c: state=IRCOMM_TTY_READY, event=IRCOMM_TTY_DATA_REQUEST
226 (0.000016): d:\projekte\...\ircomm_ttp.c(), clen=0
227 (0.000015): d:\projekte\...\irttp.c() : queue len = 0
228 (0.000016): d:\projekte\...\irttp.c() : send_credit = 1, queue_len = 1
229 (0.000993): ==> E0 3C 1D 17 00 00 16 10 02 34 00 02 04 03 00 10 03 4D D6 16 10 02 35 00 02 04 FB DF 10 03 A8 8C
                    à  <                    4                    M  Ö           5           û  ß        ¨  Œ
```

- Manual packet parsing required

- Both sent or received packets of IrDA2k and MS-IrDA can be captured!
- Remote diagnosis:
  - Is IrCOMM2k activated or is just MS-IrDA running?
  - Does the IR device connect?
  - Why does the connection break down?
  - Is the remote device really IrDA compliant?

IrDA and Ethereal

- IrDA plugin for Ethereal
- No modification of Ethereal required
- First version by Shaun Jackman (2000, UDP-encapsulated)
- New approach: Extension replaces SunATM frame format
- Uses ATM pseudo header
  - Direction (received/sent)
  - Inserted log messages



IrDA and Ethereal (2)

- Offline capturing to libpcap file
  - Windows: irda2kdump -o <file>
  - Linux: irdadump -o <file>
    (no log message support)
- Real-time capturing with modified WinPcap
- Modified libpcap on Linux?
- Full integration in Ethereal?
  - requires new file format
  - requires new packet type
- Offline capturing simply by pressing a button (Windows users...)

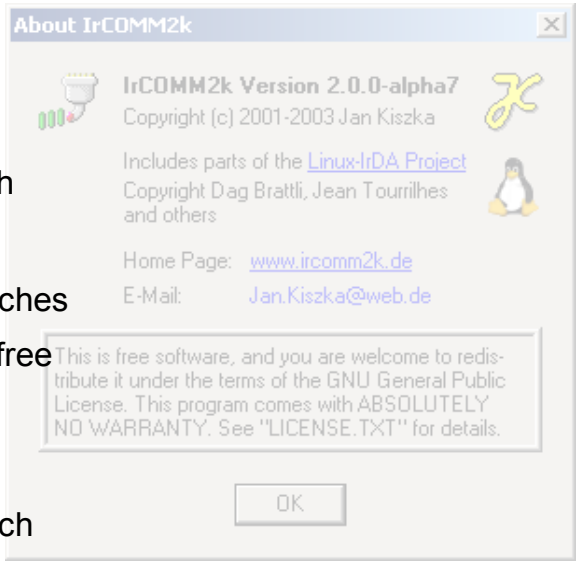
IrDA Monitor

- Yet simple monitoring (and configuration) tool irmon2k
- Link indication in task bar (“Am I already connected?”)
- Still only visions (a lot of work...):
  - Link parameter visualization (link speed, link quality, etc.)
  - Local and remote IAS browser
  - More configuration parameters (Linux-IrDA's /proc variables)
  - Portable implementation (using WxWindows or Java)
- Linux: GNOME IR monitor (girda)
  - Has to polls for discovery results every 2 seconds
  - Common event driven interface would be nice...
    (IrDA2k: blocking IOCTL of debug character device)

- Parameter visualization also includes alarms when link is interrupted
- Event IOCTLs of IrDA2k:
  - Wait for event (at the moment: connected/disconnected, IrCOMM2k active/inactive)
  - Get last event
- Linux-IrDA:
  - /dev/irnet can report events (but only IrNET related)

IrCOMM2k Status Overview

- Version 1.2.1:
  - stable (with known drawbacks)
  - support has been stopped
  - Thousands of downloads/month
- Version 2.0.0-alpha7:
  - Based on 2.4.20 + skb-leak patches
  - Stable driver core, but not bug-free
  - Difficult setup procedure
- CVS Version (06/2003):
  - Based on 2.5.67 + skb-leak patch
- New setup tool under development (Timothy Gack)



- Version 2 core status:
  - Some PSIONs (Symbian OS) do not connect reliably
  - Connection breakdown during long file transfers
  - ➔Unclear if bug in IrCOMM2k or Symbian OS (no test device available)
  - ➔Jean Tourrilhes: maybe due to IrTTP bug in 2.4.20, should be fixed in 2.5.67
- New contributors are always welcome!

Synergy Effects

- Several hidden bugs were discovered and fixed
- Common protocol analyzer
- Develop common GUI?
- Improve IrCOMM usability?

Let's think further:

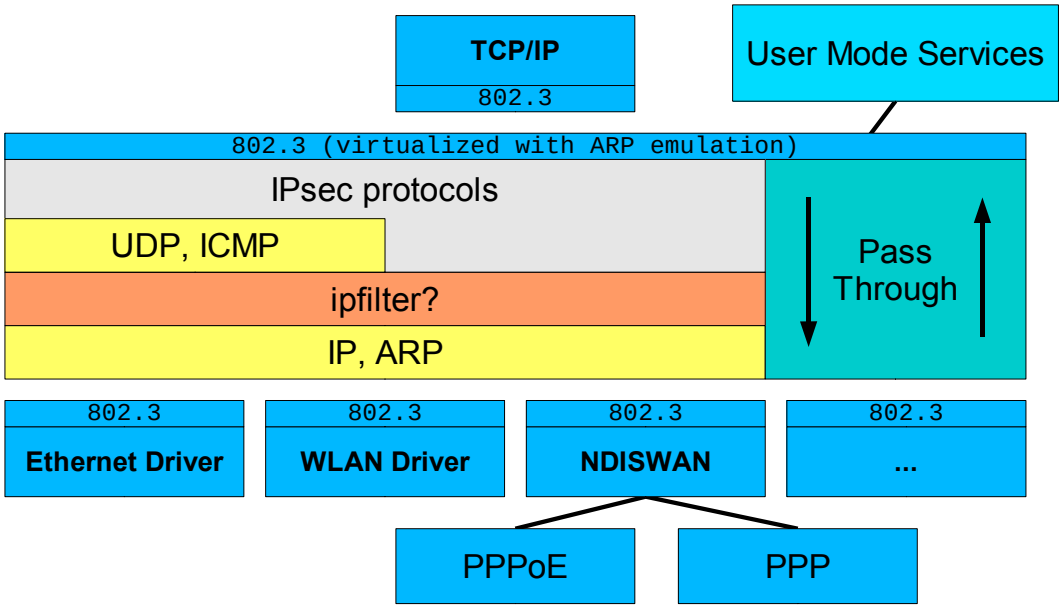
- Bluetooth plugin for Ethereal?
- Linux Bluetooth for Windows?
  (An expert: “Linux currently provides the best implementation.”)
- TCP/IP with IPsec...?

- Feedback to Linux-IrDA:
  - Encouraged code revision to fix skb-leaks
  - Solved very rare IrLAP connection problems
  - Corrected IrCOMM status lines initialization
- IrCOMM usability issue:
  - several applications listening on incoming IrCOMM connections, i.e. multiple COM ports are open
  - Which port shall be used?
    (IrCOMM spec suggests IAS InstanceName attribute, but no device queries it)
  - Solution: Assign devices to listening ports based on their nicknames and/or device addresses (similar approach in Linux-IrNET)
  - Configuration interface required

Another Issue: IPsec clients

- How to communicate securely over insecure networks (scenarios: WLAN, road warrior access)?
  - ➔ IPsec tunnels
- Yet very poor usability, especially on client side
- Situation on Windows (client):
  - Only one full-featured client (SSH Sentinel, commercial)
  - Weak system integration (e.g., when changing networks)
  - Some stability and interoperability issues
  - Not easily pre-configured distributable (Version 1.3) – or not free
- Situation on Linux (client):
  - Missing DHCP-client support for IPsec
  - Scripts could be used for automated setup and profile switching

New IPsec for Windows?



- Consequently applied abstraction: virtual NIC
- Virtual NIC contains all required components for IPsec tunnels
  - TCP/IP stack to contact VPN gateway independently
  - Filters to avoid illegal traffic forwarding
  - IPsec protocol (tunnel mode only)
- Use FreeS/WAN components (known to be very stable)

Conclusion

- IrCOMM2k provides missing virtual COM ports for Windows 2k/XP
- Based on almost unmodified Linux-IrDA stack
- Commonly usable components:
  - Ethereal IrDA plugin
  - GUI for configuration and monitoring [planned]
- Good example for software reuse in open source projects
- Reuse improves software quality
- Porting kernel components can be benefiting for both systems – and especially for the open source idea
- Suggested new project:
  IPsec client for Windows based on Linux implementation

Any Questions?

www.ircomm2k.de/english

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- Acknowledgments
  I would like to thank Jean Tourrilhes for his very helpful comments on these slides.

- Some more references
  - Linux-IrDA:
    http://irda.sourceforge.net,
    http://www.hpl.hp.com/personal/Jean_Tourrilhes/IrDA/IrDA.html
  - Windows Platform SDK: IrDA
    http://msdn.microsoft.com/library/default.asp?url=/library/en-us/irda/irda/irda_start_page.asp
  - Window DDK: Network Devices and Protocols (includes IrDA miniport drivers)
    http://msdn.microsoft.com/library/default.asp?url=/library/en-us/network/hh/network/netdg_2hd3.asp
  - Infrared Data Association:
    http://www.irda.org
  - IrCOMM2k's SourceForge site:
    http://sourceforge.net/projects/ircomm2k