



# Embedded OS/2

Using OS/2 Warp for  
information appliances



# What is an Embedded System?

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- Hardware that provides a specific functionality
- A "black box" system (no exposure of internals to the user - no maintenance)
- Special software inside to control the hardware

Both hardware and software are designed to fulfill **one** specific purpose



Achim Hasenmüller  
achimha@innotek.de

# Evolution of Embedded Systems

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## ■ ASICs

- *Application Specific Integrated Circuits* are chips that are designed for one special purpose and have everything in silicon
  - Long time and high costs for development
  - Cheap when manufactured in big numbers

Only used for rather simple logic and very high volume production



Achim Hasenmüller  
achimha@innotek.de

# Evolution - contd.

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## ■ Microcontrollers

- General purpose controllers that have several I/O ports and can be programmed using a special tool (programming language)
  - Very popular for simple controlling applications
  - Cost per chip higher than for ASICs
  - Reduced development time
  - Special tools and software required



# Evolution - contd. 2

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- **Microprocessors and Embedded Operating Systems**
  - Very complex applications possible
  - High processing speed
  - Very productive and powerful operating system services available
  - Operating systems available for more than one microcontroller, portability
  - Development can be done in C for most systems



Achim Hasenmüller  
achimha@innotek.de

# Evolution - contd. 3

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## ■ Industry Standard PC Hardware

- Very powerful hardware available  
(PowerPC, x86, ...)
- High volume standard chips mean relatively low prices
- Many complete designs available  
(motherboards, subsystems)
- Huge amount of software available
- Very advanced development environments and tools



Achim Hasenmüller  
achimha@innotek.de

# Operating Systems for x86

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## ■ DOS (MS, IBM, Caldera, ...)

- Cheap (or even free!) software license
- Limited capabilities (no GUI, multitasking)

## ■ Windows 95/98

- Very expensive license
- Poor reliability
- Limited customization possibilities

## ■ QNX

- Powerful multitasking, thin system design
- Limited software support, few development tools



Achim Hasenmüller  
achimha@innotek.de





# Operating Systems for x86 - contd.

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## ■ Windows CE

- Limited software compatibility
- Too thin for demanding appliances

## ■ Windows NT (Embedded)

- Very expensive software license
- Very fat system
- Limited customization possibilities
- Huge software and development tools portfolio



Achim Hasenmüller  
achimha@innotek.de

# Operating Systems for x86 - contd.

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## ■ Linux

- Stable and powerful operating system
- Free software - no royalties
- Source code available, perfect customization possibilities - but problems with GNU license for modifications
- Source code often **has** to be modified to achieve customization
- X as the graphics subsystem is very fat and not really suited for embedded systems
- Missing compatibility to DOS and Windows



Achim Hasenmüller  
achimha@innotek.de

## Departures

Montreal	AC865	Go to gate 28
Paris	ME202	Go to gate 5
London	AC857	Go to gate 23
Newark	AA093	Go to gate 7
San Francisco	AA067	Go to gate 18
New York	UA992	Go to Lounge
Atlanta	ATL11	Go to Lounge
Boston	BI098	Gate open gate 9
Denver	AC897	Go to Lounge

Leave baggage unattended

12:00

colourmaster

A fatal exception 0E has occurred at 0028:0000A313 in VXD VMM32  
00009313. The current application will be terminated.

- Press any key to terminate the current application.
- Press CTRL+ALT+DEL again to restart your computer. You will lose any unsaved information in all applications.

Press any key to continue

colourmaster

# NOTHING

ONLINE

# What about OS/2?

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- Surprisingly cheap license
- Very reliable and extremely efficient multitasking (low latency time)
- Excellent customization possibilities
- Very big choice of software and development tools available
- Runs well on flash disk systems
- Unmatched DOS (+ Win 3.1) support
- Very good Unix source level compatibility (EMX, Posix/2)



Achim Hasenmüller  
achimha@innotek.de

# The Original Embedded OS/2

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- There has been a project at IBM Japan with the goal to create a stripped down version of OS/2
  - Only a subset of the OS/2 APIs supported
    - Limited application support
  - Advantages over established systems such as QNX, Nucleus?

When talking about "Embedded OS/2",  
it's about using standard OS/2 for  
embedded systems



Achim Hasenmüller  
achimha@innotek.de

# Startup Time

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- OS/2 is a relatively big system with a long startup time. There are several ways to reduce it considerably:
  - Remove unnecessary drivers and speedup driver initialization (f.ex. IDE driver)
  - Use hardware suspend features if available (write memory + system state to HDD)
  - Use OS/2's hibernation mode (several restrictions apply)
  - Use a flash IDE disk-on-chip for the startup files if HDD present



# Embedded Systems with OS/2

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- The vast majority of all Automated Teller Machines (ATM) run OS/2 Warp
- Flight information terminals mostly run OS/2
- Tomahawk Cruise Missiles (?)
- Large number of industry control systems run OS/2
- Nuclear power plants run OS/2 systems at various places
- Stock quote ticker from b.i.s. AG
- Emerging market: Set-top-boxes!



Achim Hasenmüller  
achimha@innotek.de

# An Example: Met@box 500

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- The met@box 500 is an internet set-top-box for TV systems with online browsing and offline data reception over the PAL TV signal (BOT)
  - Based on the Cyrix MediaGX 200MHz integrated x86 design
  - 64MB RAM
  - 9GB HDD for offline content storage
  - Infrared keyboard
  - Integrated 56kbs modem
  - BOT decoder board



Achim Hasenmüller  
achimha@innotek.de



# BOT - Broadcast Online TV

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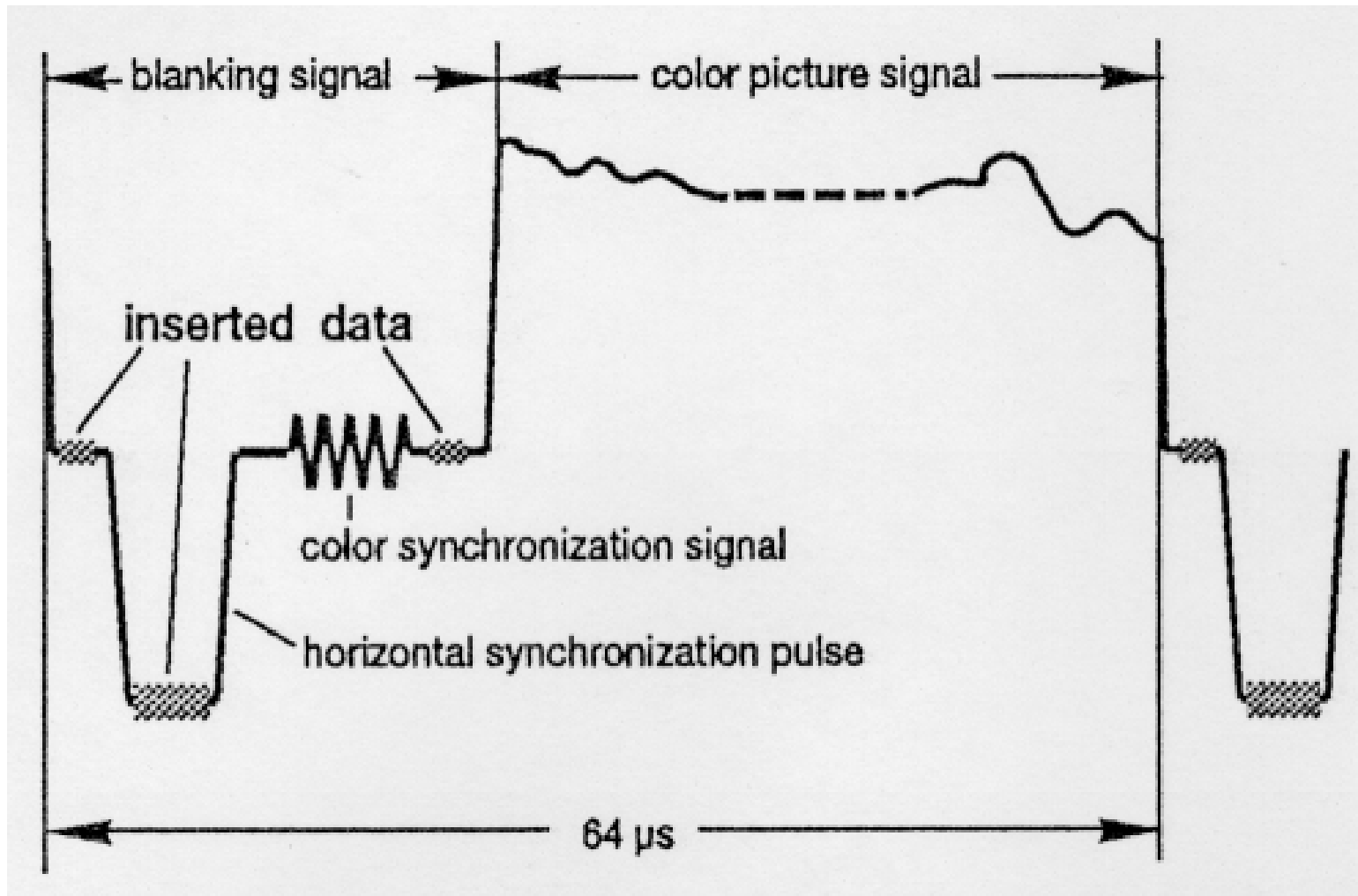
- Jointly developed by Deutsche Telekom, TU Dresden and Metabox AG, protected by international patents
- Uses the horizontal blanking interval of the standard TV signal to transmit data
  - Vertical area used by f.ex. Intericast usually not available in Europe ("Videotext")
- Speed from 79KBit/s up to 3,4MBit/s
- Inserted at the TV station, point to multipoint over satellite, cable, ...



Achim Hasenmüller  
achimha@innotek.de

# BOT technology overview

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Achim Hasenmüller  
achimha@innotek.de

# MPEG 1 Software Video

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- Using the OS/2 DOS emulation, a software decoder has been developed that directly accesses the hardware
  - The hardware is just good enough for the MPEG player with all optimizations possible
  - An OS/2 program would have to use a special device driver for direct hardware access
    - DOS programming is much easier because of direct hardware access



# Internet EMail Client

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- Frontend is Netscape Navigator
  - Powerful layout possibilities
  - User interface consistency
- All pages are dynamically constructed using Rexx as the CGI language
- Email exchange is done using a C frontend for SMTP and POP3
- IBM has created a hook in Netscape to call external email programs when the user clicks on *mailto:* tags



Achim Hasenmüller  
achimha@innotek.de

# Fax client software

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- Frontend is Netscape Navigator
  - Same interface as email software
- Backend has been developed in Rexx and uses the incredibly powerful and lightweight Fax framework from Dr. Harald Pollack ([www.buntspecht.de/fax](http://www.buntspecht.de/fax))
- Fax images use the TIFF file format which Netscape does not support so a special TIFF image plugin has been developed



Achim Hasenmüller  
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# Web server

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- Development has started with Apache under OS/2
  - Very resource consuming due to heavy use of the old Unix fork() process model
  - Several reliability problems observed
- Apache has been replaced by Xitami
  - Extremely slim and fast
  - Single process modell
- In the future, Apache will be used when it supports native OS/2 threads because of features and better source code



# Internet Resources

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- **IBM "Embedded OS/2" Homepage**

<http://www.software.ibm.com/sw-sell/oem-sw/oemproducts/opsys/embos2home.html>

- **Metabox AG**

<http://www.metabox.de>

- **BOT - University of Dresden**

<http://www.ifn.et.tu-dresden.de/english/bot.htm>

- **InnoTek Systemberatung GmbH**

<http://www.innotek.de>



Achim Hasenmüller  
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