Embedded Linux: Coming Soon to a Device Near You

Wednesday, May 4, 2005

2 p.m. Eastern /11 a.m. Pacific

Presented by

Welcome

Rick Lehrbaum

Executive Editor
LinuxDevices.com

Today's Agenda

- Murry Shohat
  - Embedded Linux: In a Device Near You

- Chris Lanfear
  - Linux Adoption Factors

- Bill Weinberg
  - Why Device OEMs Look to Linux

Featured Speakers

Murry Shohat
Executive Director
Embedded Linux Consortium

Chris Lanfear
Embedded Software Group Manager
Venture Development Corporation

Bill Weinberg
Open Source Architecture Specialist
Open Source Development Labs

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Poll 1

Please rank your awareness of Linux as an <u>Embedded</u> operating system:

- Very much aware. Linux has reached it's tipping point and marches forward
- Somewhat aware. I've heard it mentioned several times, or read about several times
- A little aware. I heard it recently or was told by a colleague
- Unaware. You're kidding, right?

Embedded Linux: In a Device Near You

Murry Shohat

Executive Director

Embedded Linux Consortium

EMBEDDED**LINUX**CONSORTIUM

Embedded Linux Overview

- What it is and how it differs
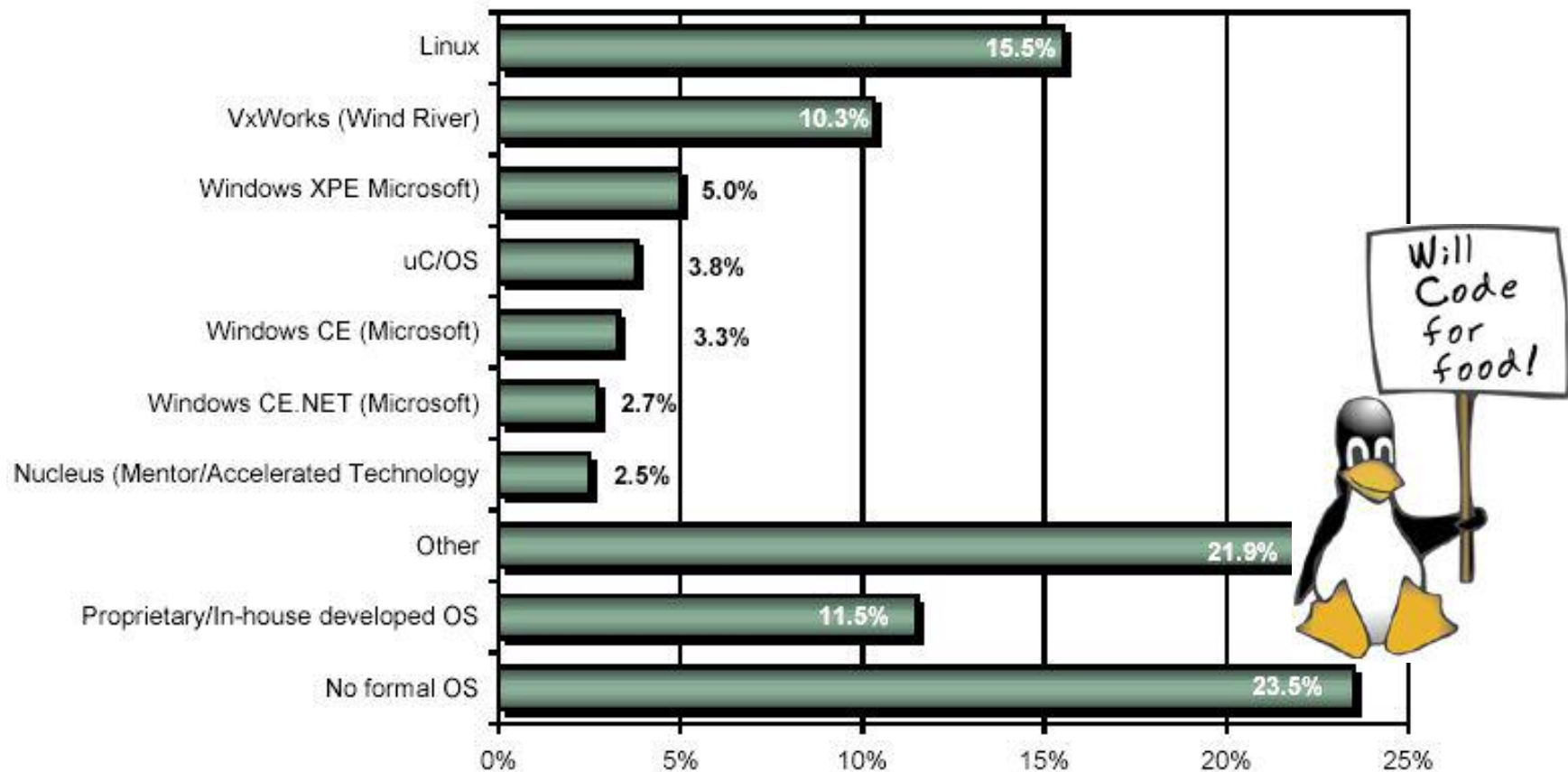
- Where it's going

- Why you should care about it

What is Embedded Linux?

- Over 90 percent of the microprocessor output of the chip industry is absorbed by embedded applications

- Every microprocessor needs an OS

- If it computes but it is not a <u>server</u>, <u>desktop</u> or <u>laptop</u>, it's an embedded application

- Embedded Linux has been positioned (by our industry) to be the #1 choice in this vast space

Embedded Linux - #1 Choice

Type of Operating System Used for the Current Project
Summary of Chart in Volume 1 Report
(Percent of Respondents, N = 523)

Operating System	Percent
Linux	15.5%
VxWorks (Wind River)	10.3%
Windows XPE Microsoft)	5.0%
uC/OS	3.8%
Windows CE (Microsoft)	3.3%
Windows CE.NET (Microsoft)	2.7%
Nucleus (Mentor/Accelerated Technology	2.5%
Other	21.9%
Proprietary/In-house developed OS	11.5%
No formal OS	23.5%

Will Code for food!

Source: http://linuxdevices.com/news/NS2744182736.html

How Does Embedded Linux Differ from Linux?

- **It doesn't differ.** Linux at the kernel level is the same in all market spaces

- Embedded is a vast space – the largest and most complex of all computing markets

- Many embedded apps require a small or tiny footprint based on cost-sensitive markets, e.g. wireless access points

- Many others approach enterprise-class architectures, e.g. Combat Information Center on a Naval Destroyer

- Linux use in embedded devices already exceeds the total # of "seats" in enterprise and desktop/laptop use

Embedded Linux Devices in Pictures

Linux is beginning to surround you at work and home.

It's going everywhere…

Cell Phones

**Motorola
E680**

**Motorola
A780**

**Samsung
Mizi**

(source: www.linuxdevices.com)

Telematics/Diagnostics

BMW 7 series

Daimler-Chrysler Starscan
Diagnostics

Volvo
ITS Mobility

(source: www.linuxdevices.com)

Global Positioning Systems (GPS)

TomTom Go GPS

Sony NV-XYZ

(source: www.linuxdevices.com)

Personal Digital Assistants (PDAs)
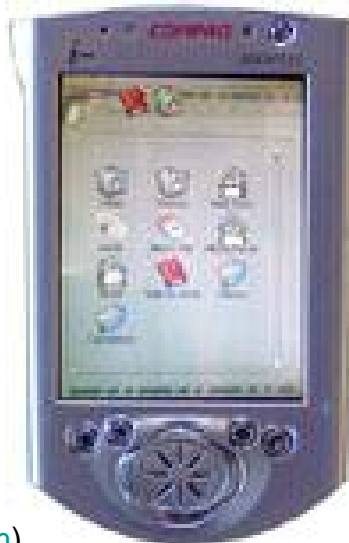
Sharp SL-C1000

Archos PMA400

Compaq iPAQ (Linux Hack)

Zaurus

(source: www.linuxdevices.com)

Smart Camera Systems

Axis 2120

AKCP Camera Probe

Sony Video
Network Station

Elphel 300

(source: www.linuxdevices.com)

Medical Diagnostics

BIAC Muscle Stimulator

CT Scanner

(source: www.linuxdevices.com)

Networking

Dlink DSL G604T

Sputnik Wireless Network Management

LinkSys WRV-54G

(source: www.linuxdevices.com)

Point of Sale & Human-Machine Interface

Eason HMI

SicomPOS at BurgerKing

(source: www.linuxdevices.com)

Robotics
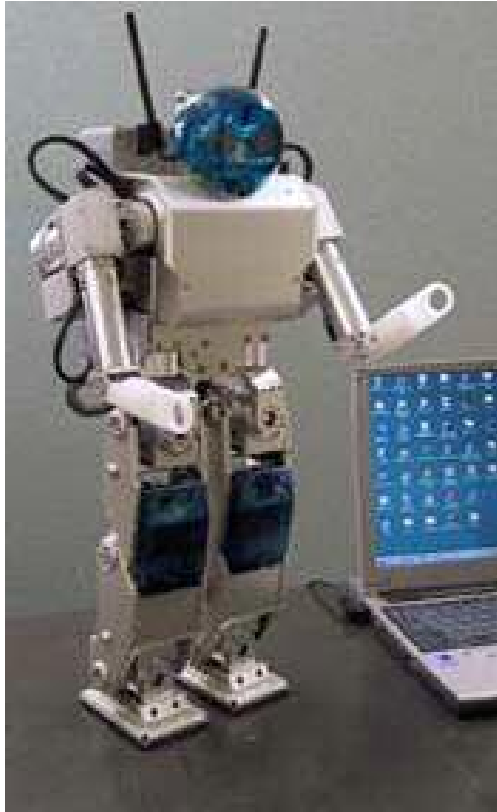
Fujitsu HOAP

Patrolbot

Isamu

Wakamaru

(source: www.linuxdevices.com)

Consumer Electronics A/V

Philips iPronto
Uber remote!

Amino AmiNet100
(Surf net on your TV)

Samsung MiniKet
Diskless camcorder/camera/mp3

(source: www.linuxdevices.com)

Will Embedded Linux Converge with Enterprise and Desktop?

- **<u>It already does</u>**. "On demand" streaming media, database-connected medical PDA's for example

- Linus says, "Watch it flow..."

- Consumers don't much care about the OS. They care about functionality.
  - Convergence based on open source concepts
  - Interoperability via Linux stays open
  - They love the new feeling of freedom with products like the Firefox browser-it drives convergence

- Convergence presents incredible new opportunities to the IT professional, for example…

Making Customized Devices

Embedded Linux enables more IT value than any other OS…

- It reduces bill of material costs
- Encourages differentiation

Intermec CK1 Batch
Data Collection Terminal

Why Should You Care?

- Computing via embedded devices offers direct connectivity with people who pay the bills – utility companies with smart, wireless meters, for example,

- Embedded devices directly impact 3rd-world markets, adding vast pools of consumers. In five years, for example, deaths from tsunamis can be eliminated

- Industries like health care delivery now have a technology solution for rising costs, e.g., the virtual office visit

- Server – Desktop – Embedded form a triangle of bidirectional services through both ends of the virtual wire. Embedded Linux rocks!

Embedded Linux: In a Device Near You

Murry Shohat

Executive Director

Embedded Linux Consortium

EMBEDDEDLINUXCONSORTIUM

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Poll 2

- Now that you mention it, I plan to take the following actions in my personal life with respect to <u>Embedded Linux</u>:

  - I'll only purchase Consumer Electronic products that use it, if an operating system is involved
  - I'll make sure that my next CE purchase interoperates with Linux-based devices
  - I don't care what operating system is being used. I buy price/functionality for today
  - I prefer CE products that run Windows so that they are compatible with my desktop and laptop, even if I have to pay more
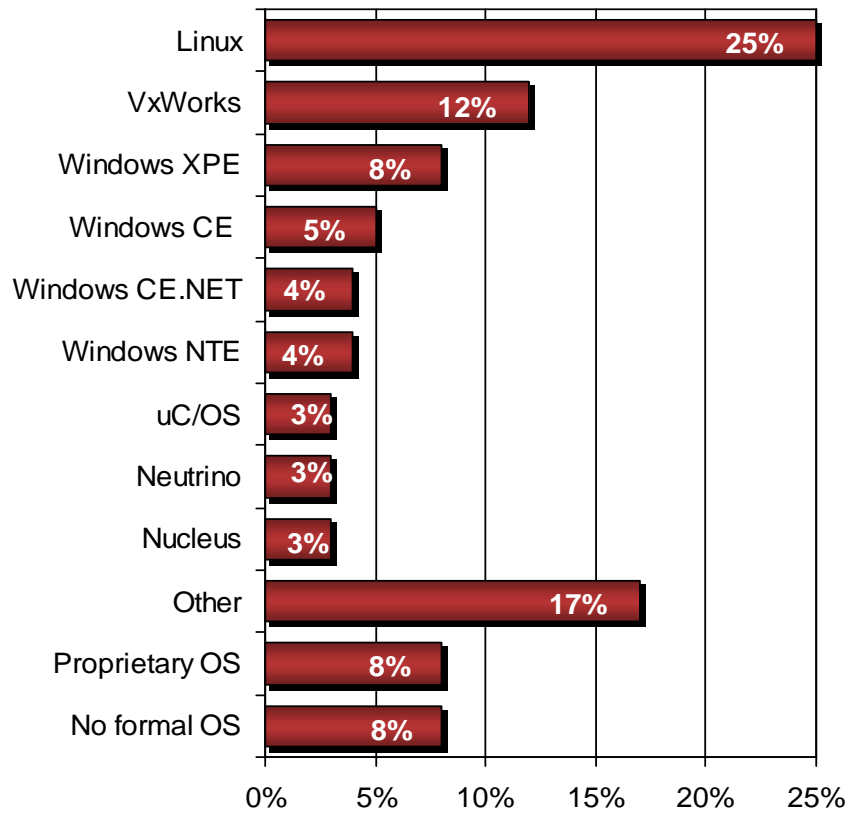
Linux Adoption Factors

Chris Lanfear

Embedded Software Group Manager

Venture Development Corporation

VDC

VENTURE DEVELOPMENT CORPORATION

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Target Embedded OS Developers are Using

Linux #1

Type of Operating System Used for the Current 32/64 Bit Project

OS	Percent
Linux	25%
VxWorks	12%
Windows XPE	8%
Windows CE	5%
Windows CE.NET	4%
Windows NTE	4%
uC/OS	3%
Neutrino	3%
Nucleus	3%
Other	17%
Proprietary OS	8%
No formal OS	8%

0% 5% 10% 15% 20% 25%
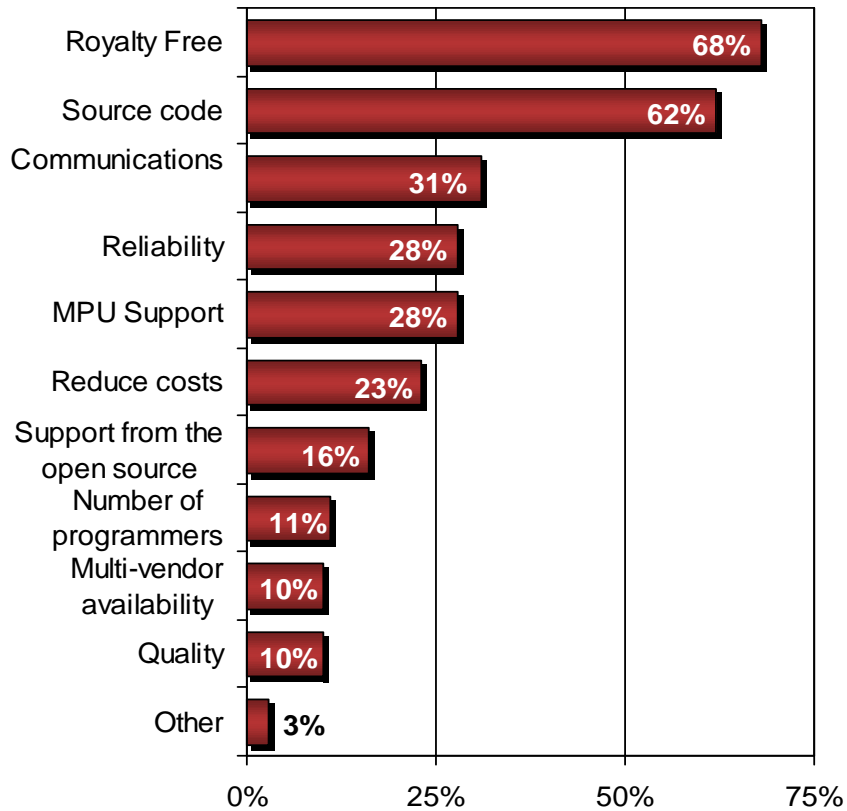
Note: Percents sum to over 100% due to multiple responses.

- Developers surveyed by VDC indicate that Linux is the top OS for their projects

- Consistent with other surveys of embedded developers

- 29% of developers survey that Linux will be the embedded OS in their "next" project - growth continues

Linux Adoption Factors

Price and technical capabilities are top

Most Important Reasons for Selecting Linux for Respondents Currently Using

Reason	Percent
Royalty Free	68%
Source code	62%
Communications	31%
Reliability	28%
MPU Support	28%
Reduce costs	23%
Support from the open source	16%
Number of programmers	11%
Multi-vendor availability	10%
Quality	10%
Other	3%

Note: Percents sum to over 100% due to multiple responses.

- Reasons for use vary
- Price does matter!
  - Royalty free, overall cash outlay
- But so do technical issues
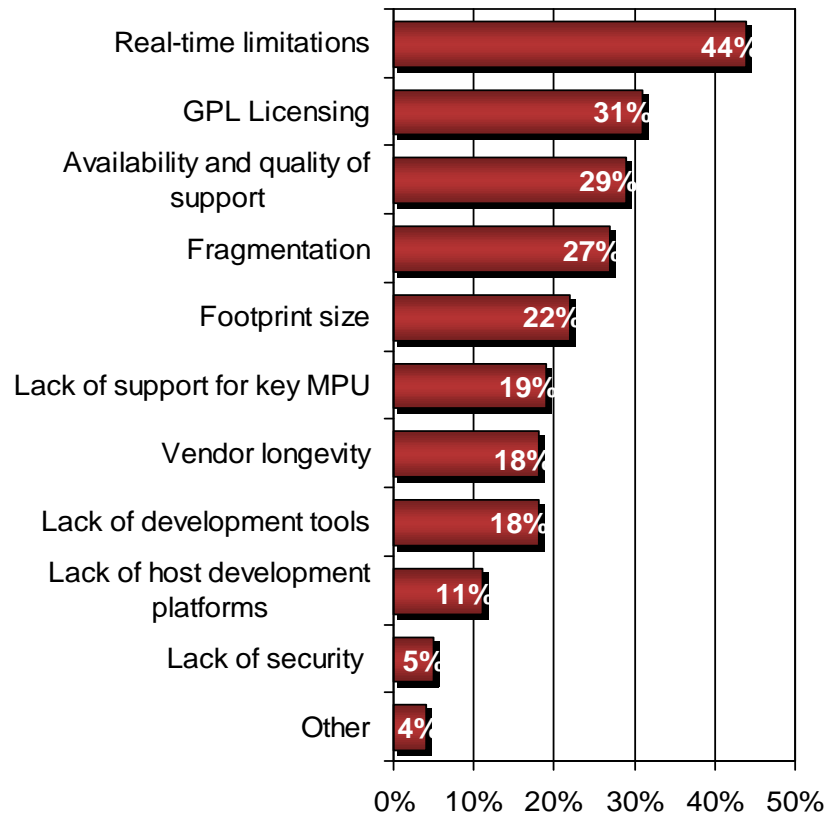 - Source code, communications, reliability
- Flexibility is the key
  - Business model, kernel

Inhibitors to Linux Adoption

Real time is top reason. Is it really that important?

Most Important Factors Inhibiting Linux Adoption for Respondents Planning to Use Linux

Factor	Percent
Real-time limitations	44%
GPL Licensing	31%
Availability and quality of support	29%
Fragmentation	27%
Footprint size	22%
Lack of support for key MPU	19%
Vendor longevity	18%
Lack of development tools	18%
Lack of host development platforms	11%
Lack of security	5%
Other	4%

Note: Percents sum to over 100% due to multiple responses.

- Real time is the Achilles heal
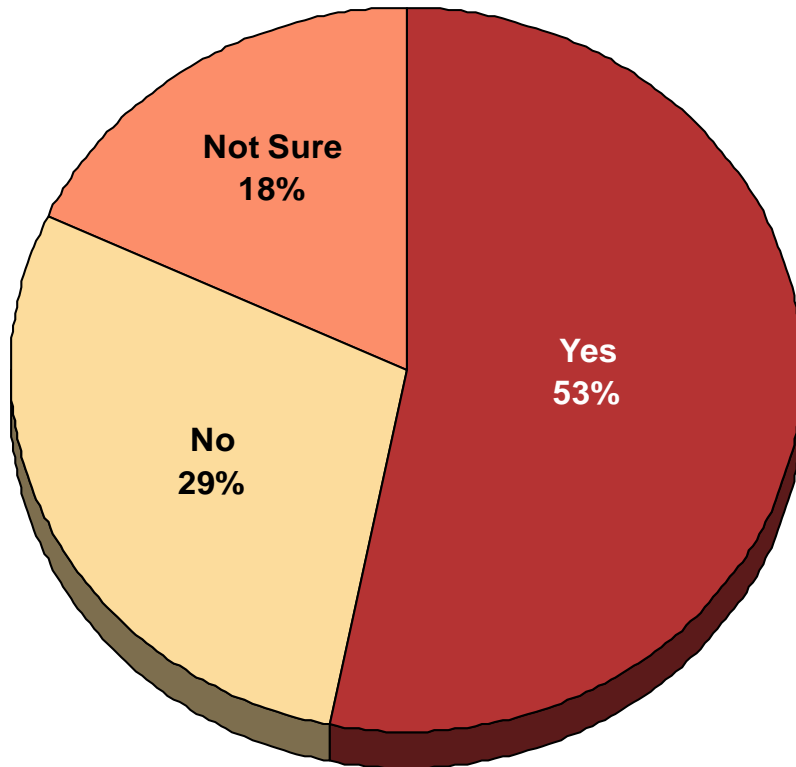 - However not many applications actually have hard real time requirements
- GPL and IP risk are also important
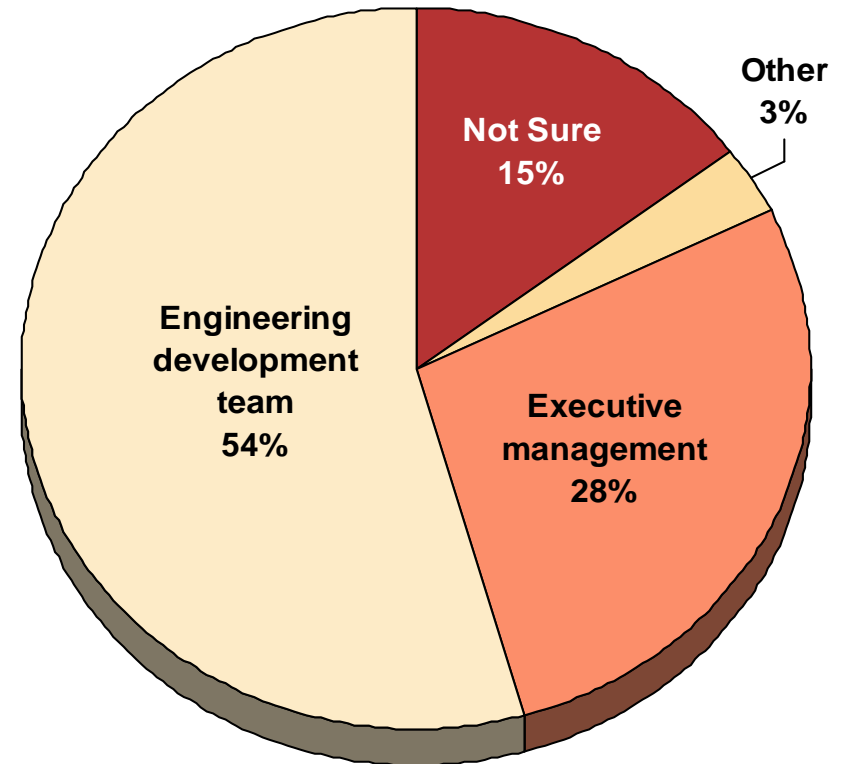 - Most OEMs evaluate IP risk

Intellectual Property Concerns

Despite concerns Linux continues to grow

Was an Assessment Made Regarding the Potential for Intellectual Property Risk?

- Yes 53%
- No 29%
- Not Sure 18%

Primary Responsibility for Linux Risk Assessment

- Engineering development team 54%
- Executive management 28%
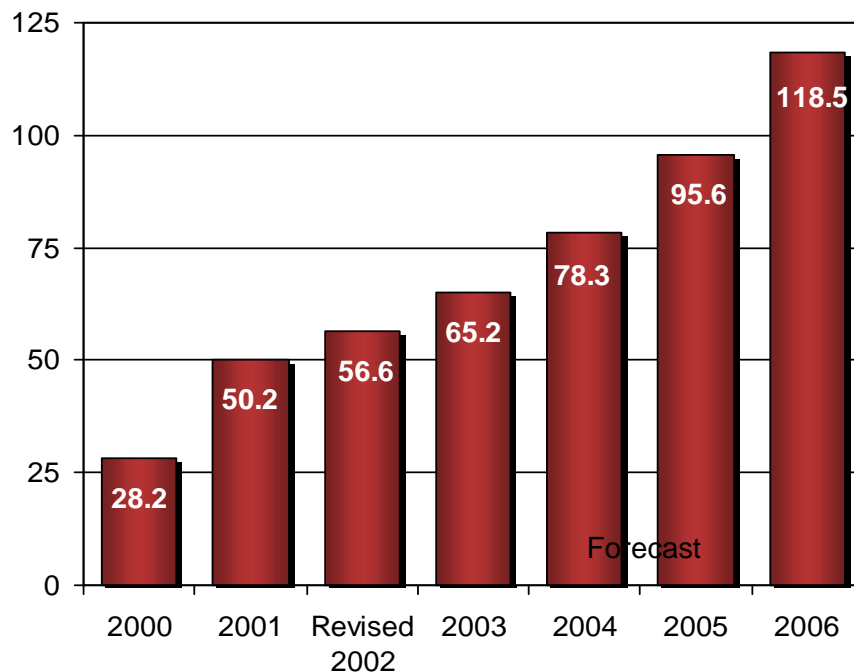- Not Sure 15%
- Other 3%

Steady, Fast Growth For Linux

Commercial market does not tell the whole story

Worldwide Shipments of Embedded Linux Operating Systems, Add-on Components, and Related Services (Millions of Dollars)

2003-2006 CAGR: 22.0%

Year	Value
2000	28.2
2001	50.2
Revised 2002	56.6
2003	65.2
2004	78.3
2005	95.6
2006	118.5

Forecast

- Faster than overall embedded OS growth
  - Many sources for embedded Linux
    - Commercial vendors
    - Board vendors
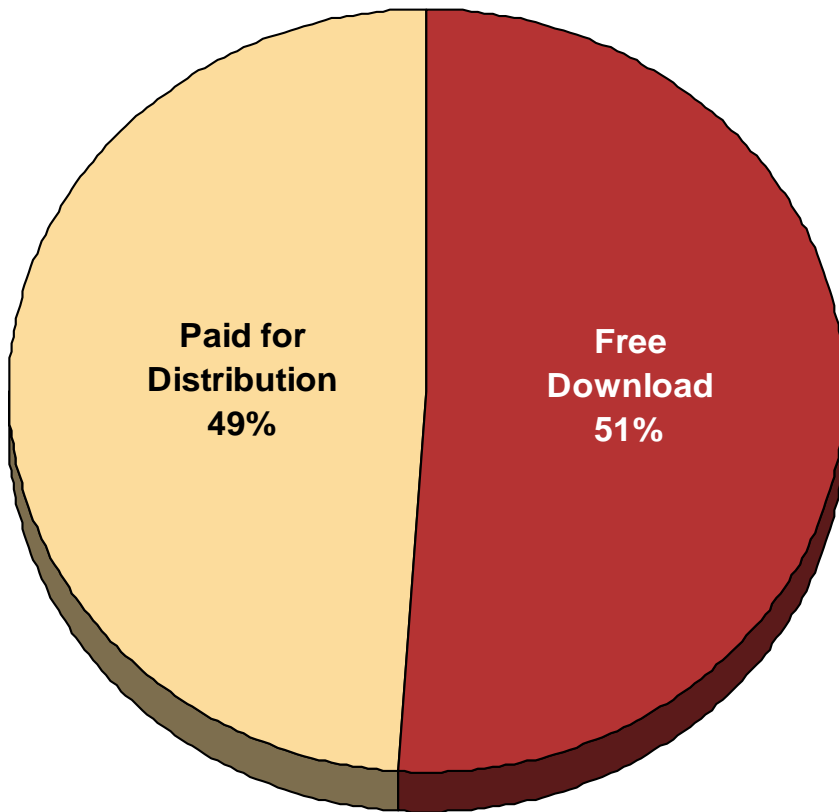   - Kernel.org
    - Shrink-wrap
- Huge "dark side" of non-commercial use

Many Sources for Linux

Slightly more developers are drawn to the "Dark Side"

Linux Distribution Paid For or Downloaded for Free

Paid for
Distribution
49%

Free
Download
51%

- Developers look to both commercial and non-commercial sources for their Linux distribution
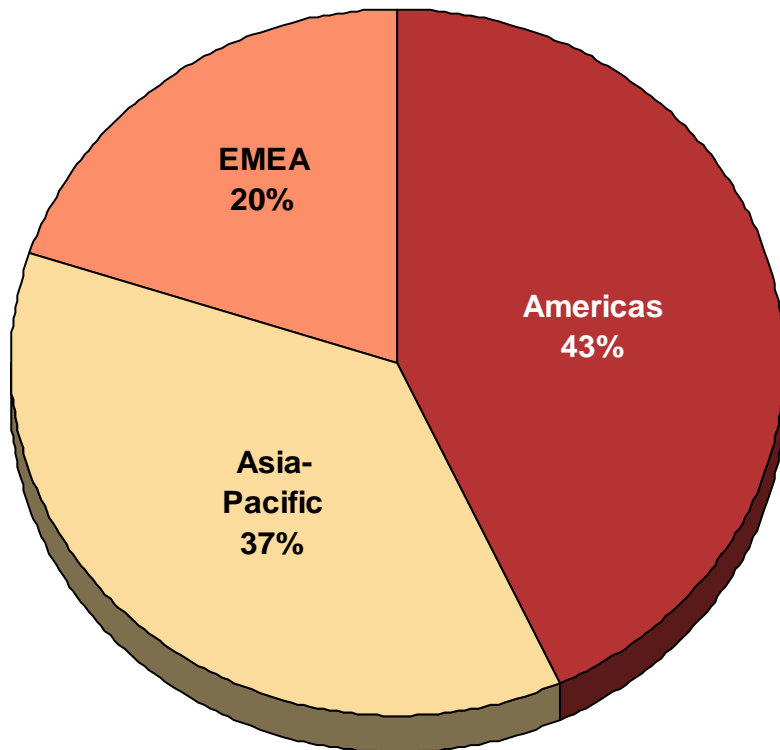
- The question is: Which way will they go in the future?

Global Linux Adoption

Americas is largest and fastest growing market

Worldwide Shipments of Embedded Linux Operating Systems, Add-on Components, and Related Services (Percent of Dollars)
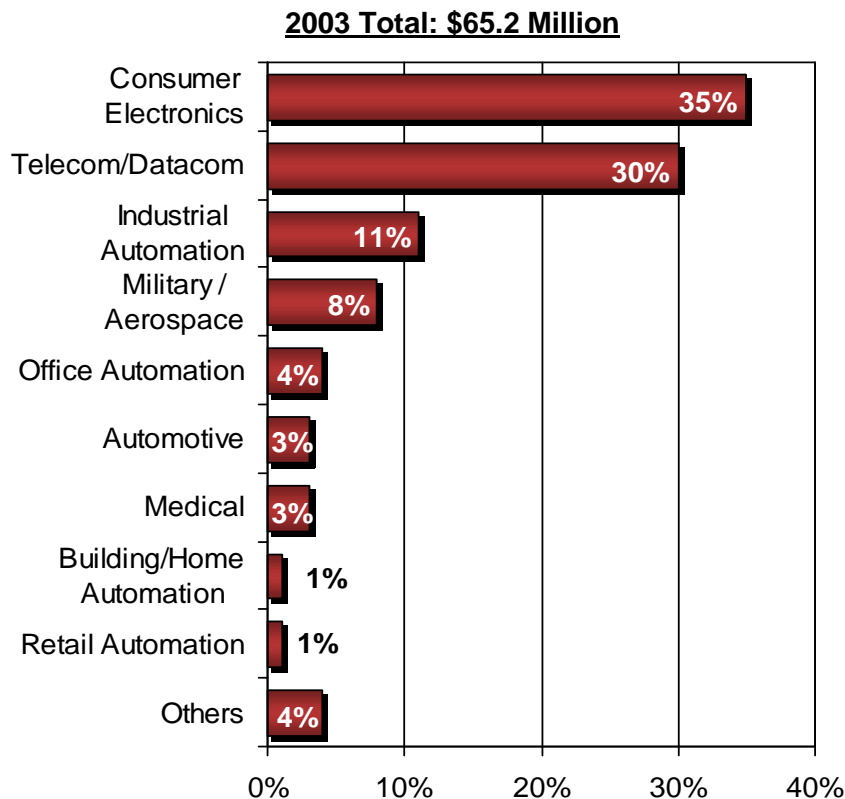
<u>2003 Total: $65.2 Million</u>

- Relatively even growth across globe
  - Americas slightly faster than other regions

Vertical Markets Adopting Linux

Consumer electronics is the leading market

Worldwide Shipments of Embedded Linux Operating Systems, Add-on Components, and Related Services, Segmented by Vertical Market
(Percent of Dollars)

2003 Total: $65.2 Million

Market	Percent
Consumer Electronics	35%
Telecom/Datacom	30%
Industrial Automation	11%
Military / Aerospace	8%
Office Automation	4%
Automotive	3%
Medical	3%
Building/Home Automation	1%
Retail Automation	1%
Others	4%

0% 10% 20% 30% 40%

- High-volume consumer electronics OEMs look to Linux for both cost savings (no royalties) but also for technical capabilities

- Telecom industry uses Carrier Grade Linux for soft real-time apps. Many dual OS devices (RTOS + Linux)

Leading Vendors

MontaVista is leading embedded Linux brand

Worldwide Shipments of Embedded Linux Operating Systems, Add-on Components, and Related Services Segmented by Leading Vendors   **(Percent of Dollars)**   **2003 Total: $65.2 Million**
MontaVista Software
Metrowerks
TimeSys
Red Hat
Viosoft
LynuxWorks
FSMLabs
ARM
SysGO AG
Lineo Solutions (Japan)

- MontaVista has emerged as the leading embedded Linux vendor

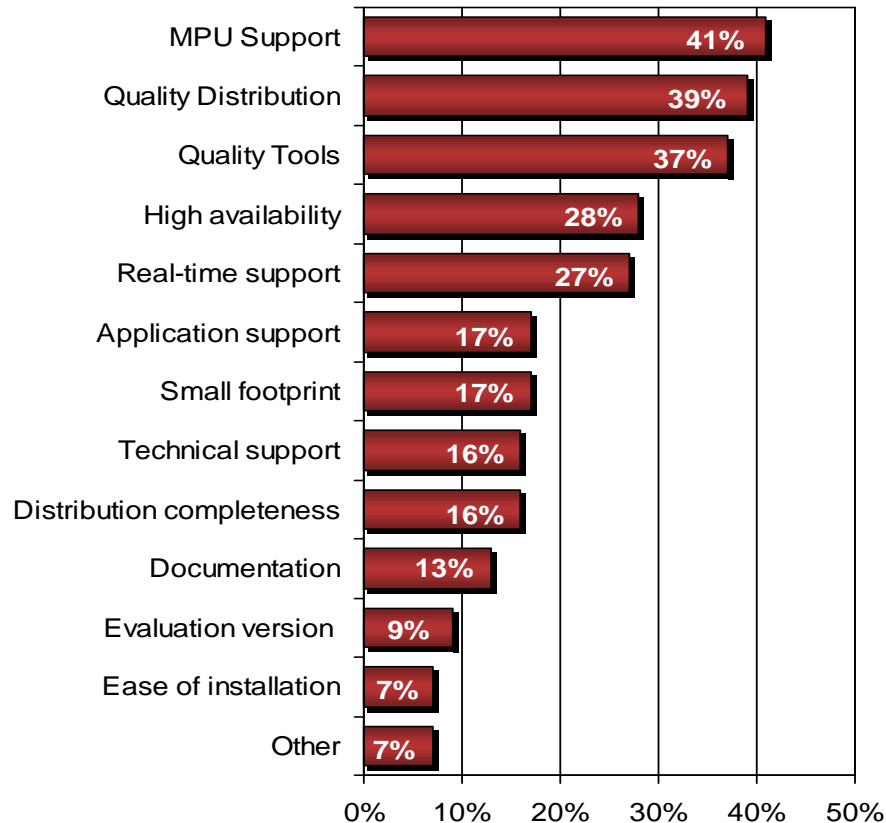- Metrowerks acquired assets of Linux shooting star Lineo

- TimeSys offers distribution and tools

- Redhat restarts Linux efforts with Wind River agreement after decline

Vendor Selection Criteria

MPU support and quality

Most Important Criteria for Selecting Linux Distribution/Vendor

Criteria	Percent
MPU Support	41%
Quality Distribution	39%
Quality Tools	37%
High availability	28%
Real-time support	27%
Application support	17%
Small footprint	17%
Technical support	16%
Distribution completeness	16%
Documentation	13%
Evaluation version	9%
Ease of installation	7%
Other	7%

0% 10% 20% 30% 40% 50%

Note: Percents sum to over 100% due to multiple responses.

- In general processors are selected first in the development processes followed by the OS

- The MPU support is the "ante" into the game for vendors

- Most of the popular 32 bit processors are supported by the leading vendors.

Linux Adoption Factors

Chris Lanfear

Embedded Software Group Manager

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Poll 3

In my mind, the connection between my organization's IT and <u>Embedded</u> Linux is:

- Very strong. We think embedded devices will be connected to our corporate data for bidirectional communications
- Strong. There are some possible applications for connecting embedded devices to our IT
- Moderate to weak. We're not sure about it yet
- No connection at all. It's not likely to happen in our organization

Why Device OEMs Look to Linux

Bill Weinberg

Open Source Architecture Specialist

Open Source Development Labs

OSDL.

Device OEMs: Why They Look to Linux

- Platform consolidation
  - Strategic hardware and software platform

- Reduced bill of material costs

- Native platform for value-added services

- Synergy with deployment infrastructure

Platform Consolidation

- For historical reasons, device OEMs support diverse, multi-tier product platforms
  - Entry-level, superior and deluxe product versions
  - Products developed by different subsidiaries or acquisitions
  - Legacy, current and next-generation development efforts

- Heterogeneous h/w and s/w raise costs
  - Multiple suppliers at lower volume/price points
  - Need to maintain separate teams for each platform type
    - Higher training, development and maintenance hosts

Consolidating Product Tiers and Technologies

High End
- Open High Level OS
- Open Environment
- Multimedia Enhanced
- High Performance Java

Middle Tier
- High-level OS
- Open Applications Environment
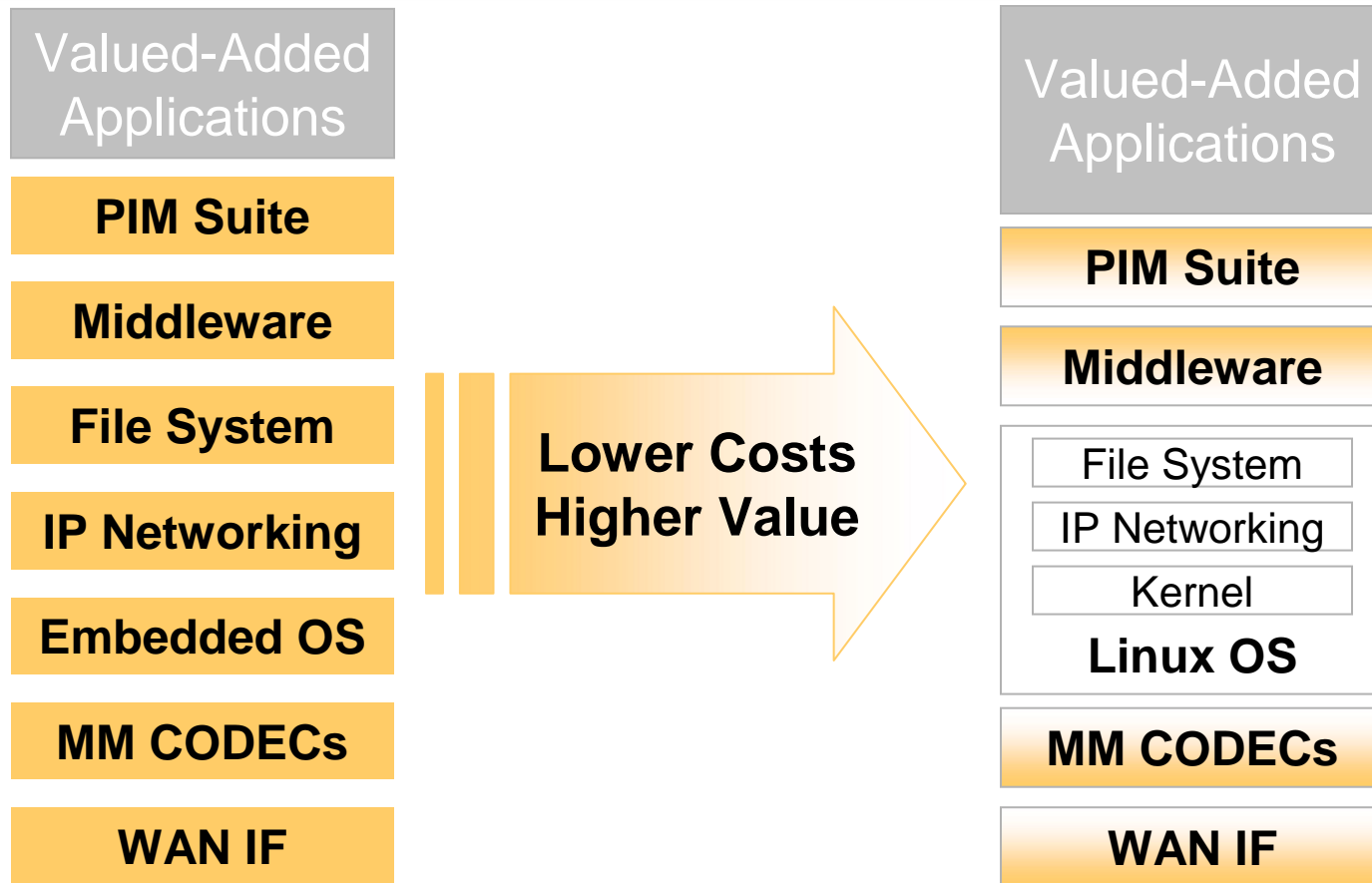- Simple Multimedia
- Java Enabled

Low End
- Proprietary OS
- Closed application
- Basic Functionality

Unified Platform
- Linux at all tiers
- H/W and S/W MM Implementations
- More features enabled at higher product tiers
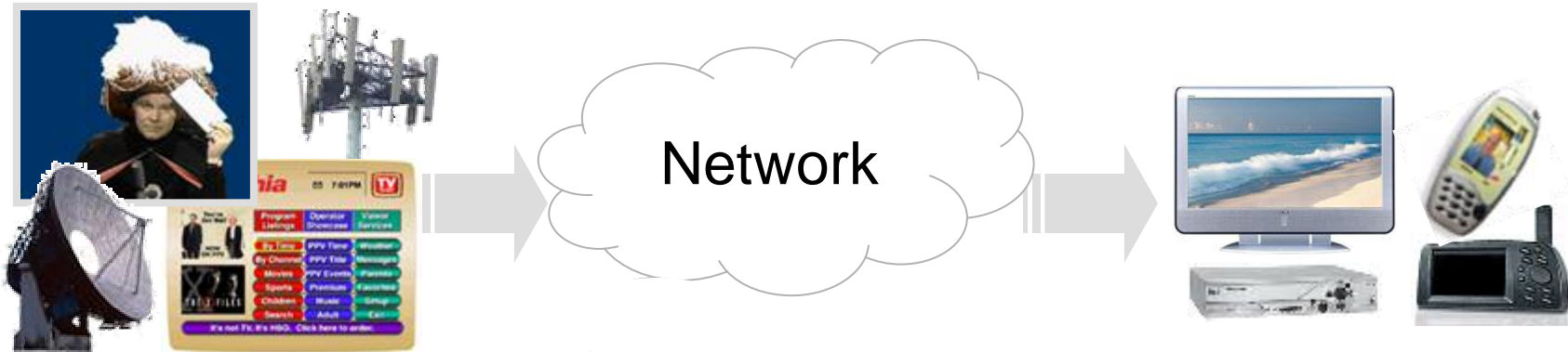
Optimizing the Bill of Materials

Valued-Added Applications		Valued-Added Applications
PIM Suite		**PIM Suite**
Middleware	**Lower Costs**	**Middleware**
File System	**Higher Value**	File System
IP Networking		IP Networking
Embedded OS		Kernel
MM CODECs		**Linux OS**
WAN IF		**MM CODECs**
		WAN IF

Proprietary Royalty-Bearing	**Either OSS or Mixed**	**Royalty-Free Open Source**

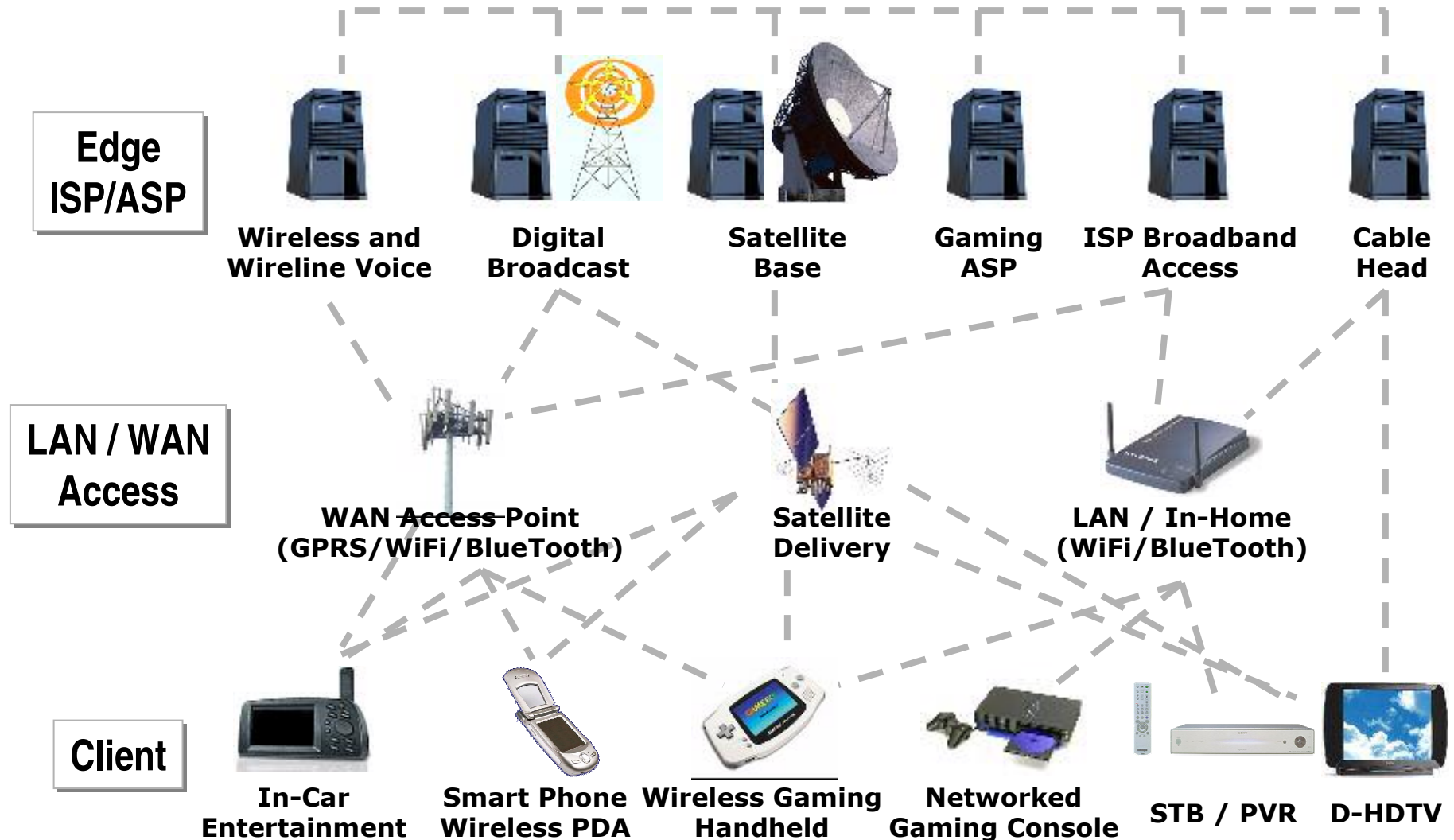# Operator/Carrier Challenge: Delivering Value-Added Services and Content

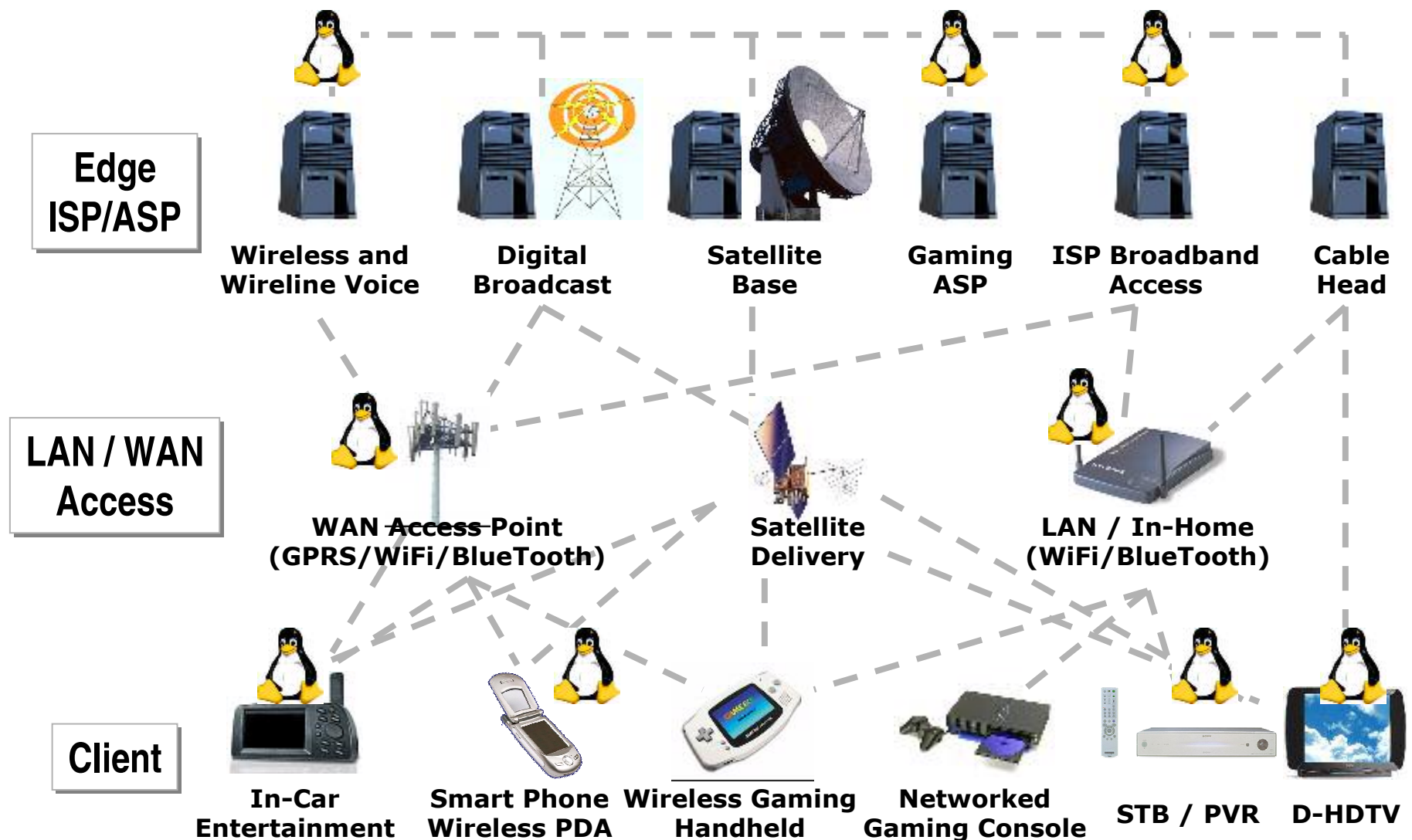Operators, carriers content providers

End-user client devices

Network

Content/Service	Legacy Delivery	Delivery w/Linux	Benefits of Linux & Open Source
Voice, video, info., games, Web, e-mail, voicemail, eCommerce, LocServices	Java, Brew, MHP/OCAP, other proprietary technologies Most require expensive m/w	Native Linux networking, file systems, security Java on Linux VoIP	Linux offers security, standard APIs and management Interfaces Base platform more capable, requiring fewer non-native add-ons **Native Performance and Lower Cost**

Service/Content Delivery Infrastructure

Edge ISP/ASP

Wireless and Wireline Voice

Digital Broadcast

Satellite Base

Gaming ASP

ISP Broadband Access

Cable Head

LAN / WAN Access

WAN Access Point (GPRS/WiFi/BlueTooth)

Satellite Delivery

LAN / In-Home (WiFi/BlueTooth)

Client

In-Car Entertainment

Smart Phone Wireless PDA

Wireless Gaming Handheld

Networked Gaming Console

STB / PVR

D-HDTV

Service/Content Deliver Infrastructure Linux Penetration and Synergies

Edge ISP/ASP

| Wireless and Wireline Voice | Digital Broadcast | Satellite Base | Gaming ASP | ISP Broadband Access | Cable Head |

LAN / WAN Access

WAN Access Point (GPRS/WiFi/BlueTooth)   Satellite Delivery   LAN / In-Home (WiFi/BlueTooth)

Client

In-Car Entertainment   Smart Phone Wireless PDA   Wireless Gaming Handheld   Networked Gaming Console   STB / PVR   D-HDTV

Why Device OEMs Look to Linux

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