

# Broadband (I): Introduction, Services, Applications, and Markets

---

**C.Courcoubetis**

**G.D.Stamoulis**

**Spring 2011**

# Outline of Material

---

- Introduction:
  - Access network and service
  - Access technologies
  - The concept of Broadband
- Broadband Services and Applications
- Broadband Markets
- DSL
- Wireless Access and Spectrum issues
- Fiber
- Other Access Media
- Concluding Remarks

---

# Introduction

# Access network - Access service

---

- **Access network:** local loop infrastructure
  - It is the 'last mile' of the network
  - Connects the user with the first network POP
  - Can use different technologies
  - Usually is the bandwidth bottleneck
- **Access service:** more complex concept
  - connects to higher level services (Internet, VoD, etc.)
  - may be layered (physical layer, data link layer)
  - bundled with information service

# Access media

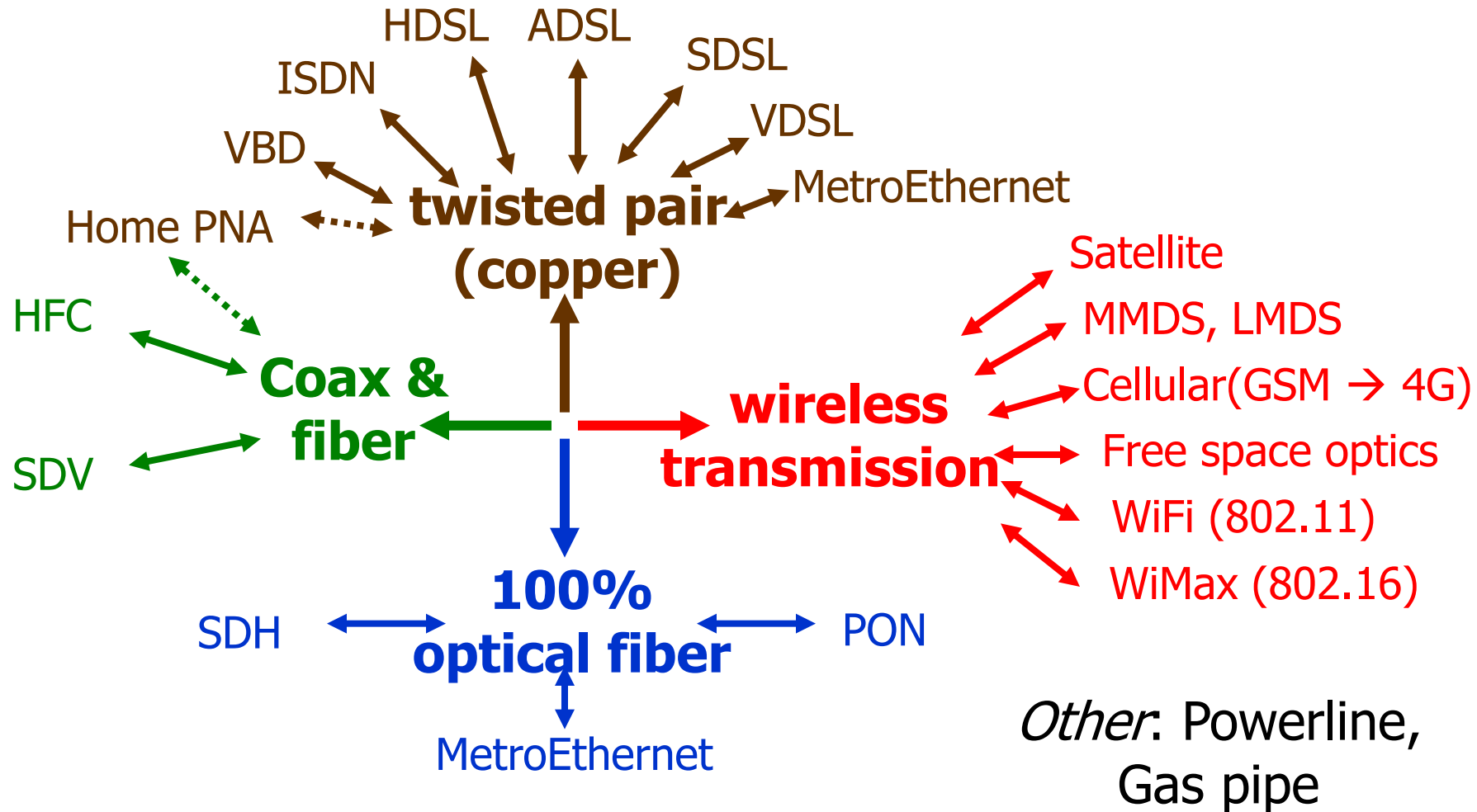
---

Wide Variety:

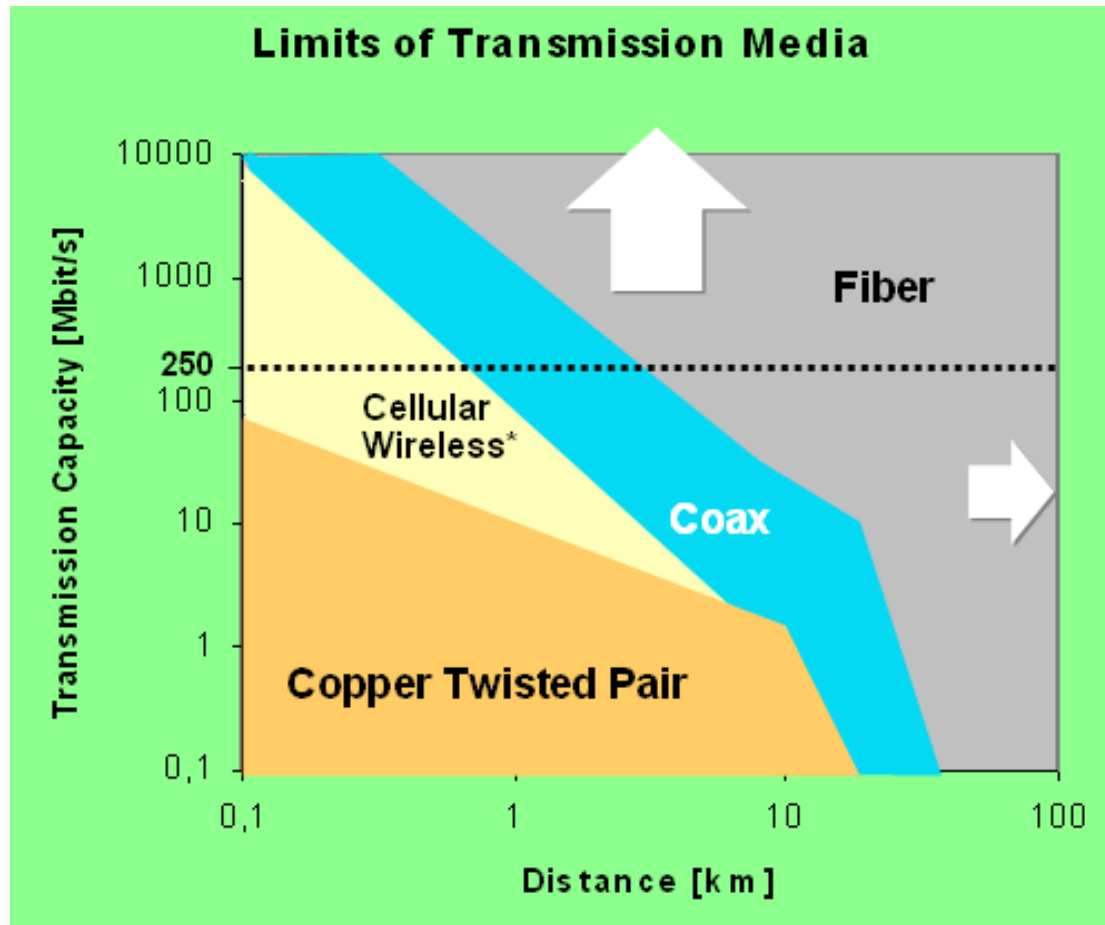
- Twisted pair (copper):
  - Digital Subscriber Line (DSL)
- Wireless
  - WiFi, WiMax, ...
- CATV Coaxial cable
- Optical fiber
- Power cable

Can serve a wide variety of applications

# Basic access technologies



# Rates vs Access Loop Length



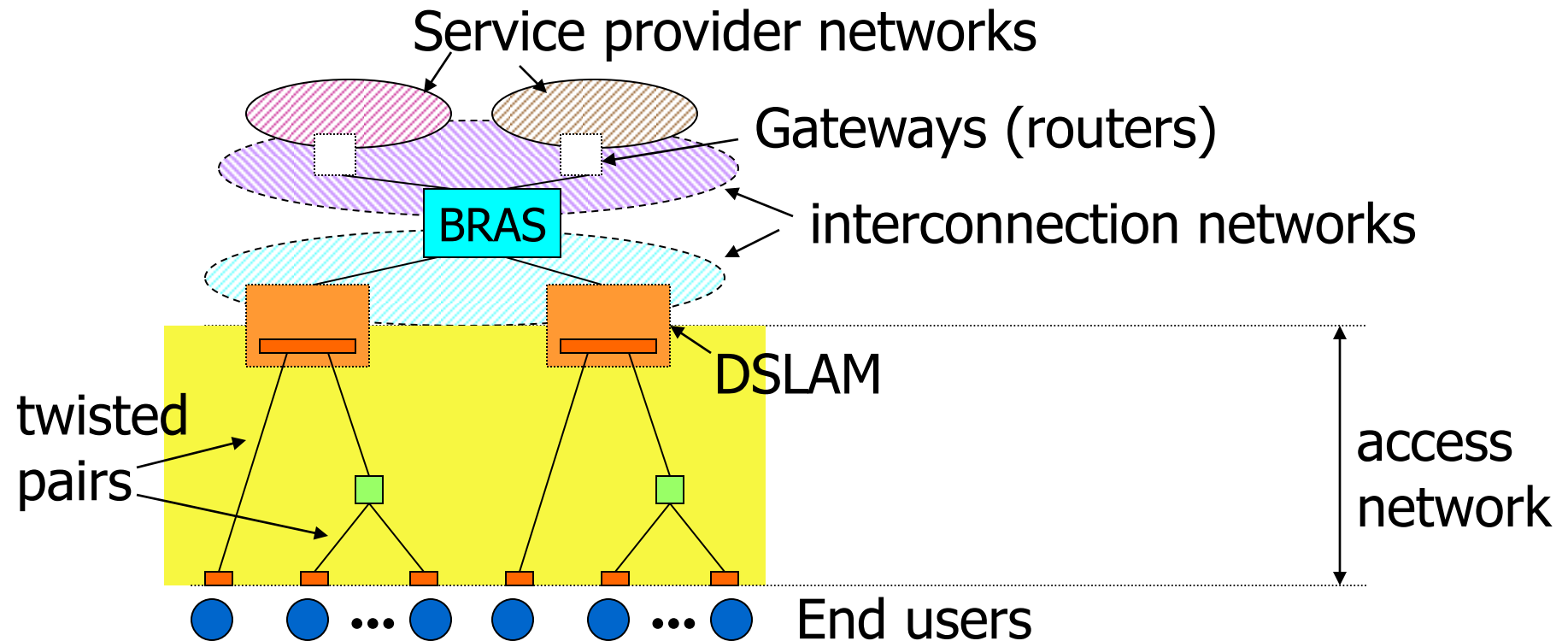
Increasing loop length

CPE



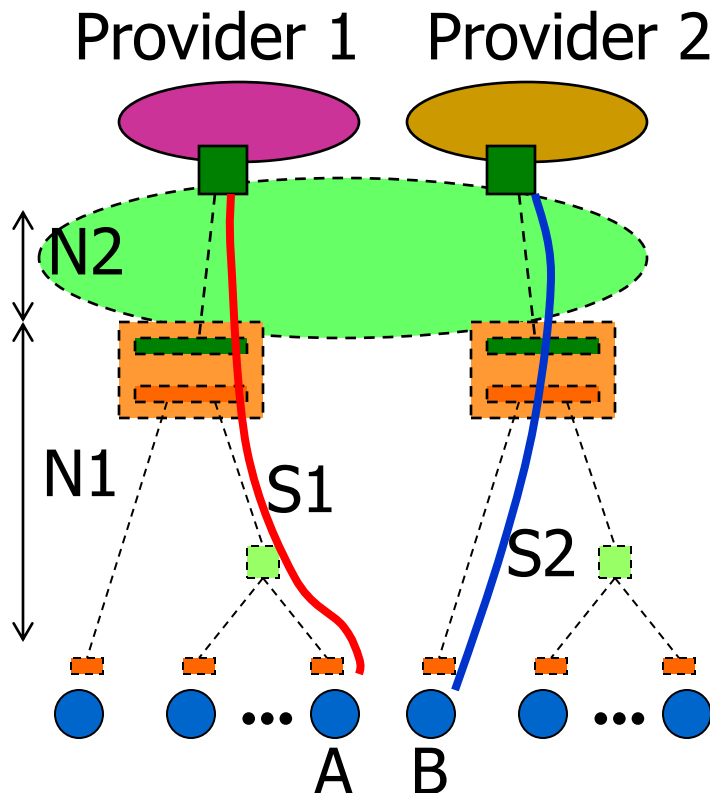
Central Office DSLAM

# Access network architecture: the case of DSL



- BRAS: Broadband Remote Access Server
- DSLAM: Digital Serial Line Access Multiplexer

# Business model for access services



- A is a customer of Provider **1** using access service S1
  - Customer A: buys (P1, S1)
  - Provider **P1**: builds S1 by buying services from N1, N2
- B is a customer of Provider **2** using access service S2
  - Customer B: buys (P2, S2)
  - Provider **P2**: builds S2 again by buying services from N1, N2
- Simple case of **value chain**

---

# Broadband Services and Applications

# Service requirements to the access network

---

Service	Type	Downstream Bandwidth	Upstream Bandwidth
Telephony	Switched	4kHz	4kHz
ISDN	Switched	144kbps	144kbps
Broadcast video	Broadcast	Analog or 6 Mbps	0
Interactive video	Switched	6 Mbps	Small
Internet access	Switched	1-... Mbps	Small initially
Videoconferencing	Switched	6 Mbps	6 Mbps
Business services	Switched	1.5-622 Mbps	1.5-622 Mbps

# Access networks go broadband (I)

---

- Local networks based on outdated principles became a **bottleneck**, limiting subscriber's access to modern services.

## Key forces:

- Data communications exceed telephony
  - Need for High-Speed Internet
- New business applications
- New subscriber's requirements to service provision

# Access networks go broadband (II)

---

Key forces towards broadband (continued):

- Development of new services in **voice, data** and **video** information
  - Millions of WWW pages with powerful video information
  - New Multimedia applications, in modes:
    - Broadcasting, On-demand, Interactive
- Development of high-speed core networks with a capacity of dozens and hundreds of Gbps

# Access networks go broadband (III)

---

Key forces towards broadband (continued):

- New **regulatory** framework enabling competition
  - Lower entry barriers; huge investments in infrastructure not required anymore
- Emergence of alternative operators in local networks, who compete with incumbent operators in provisioning a wide set of additional services
- Wireless technologies have progressed and are being widely adopted
  - Wireless/mobile subscribers exceed landline subscribers

# What is a broadband access service ?

---

## ■ Always on

- Easier and more convenient to use, instant gratification
- Heavier use

## ■ High speed, simultaneous provision of downstream and upstream

- Bit-rate exceeds (often by far) ISDN 144kbps

## ■ Low latency: Necessary for interactivity

# Comparison of download duration

Wireless wired		E-mail	MP3 or high resolution photo	1 h video MPEG 4 in TV-Quality
Byte bit/s		3 k	3 M	300 M
<b>GSM</b>	<b>9,6 k</b>	2,5 sec	42 min	3 days
<b>PSTN</b>	<b>56 k</b>	0,4 sec	7 min	12 hours
<b>GPRS</b>	<b>115 k</b>	0,2 sec	3,5 min	6 hours
<b>ISDN</b>	<b>128 k</b>			
<b>UMTS</b>	<b>2 M</b>	0,01 sec	12 sec	20 min
<b>ADSL</b>	<b>8 M</b>			
<b>Cable</b>	<b>30 M</b>	1 ms	1 sec	30 sec
<b>WLAN</b>	<b>80 M</b>			
<b>Fiber</b>	<b>800 G</b>	30 ns	30 µsec	3 ms

Live Video Codecs starting with 32 kbit/s

# Main areas of broadband applications

---

- High-speed Internet, both for residential and business customers
- Enterprise applications:
  - VPNs
  - Storage Area Networks, Data Centers, Server Farms
  - Grid, Cloud Computing
- Tele-working and remote collaboration
- E-Government
- E-Health

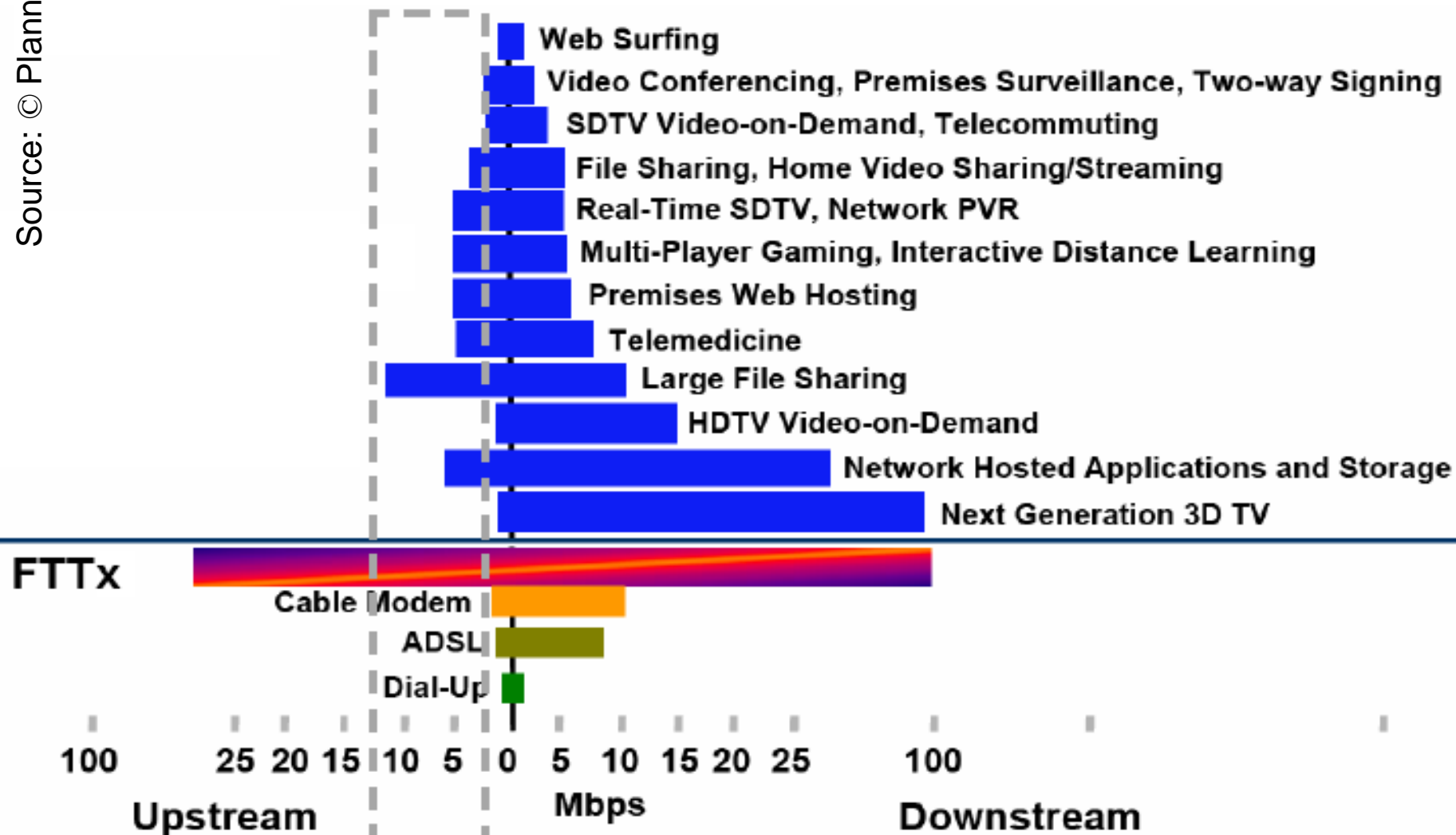
# Main areas of broadband applications

---

- E-Learning
- Peer-to-peer file-sharing
- E-Home with infotainment and telematics
  - IP-TV, Video-on-Demand
- Online Gaming
- Security applications: e.g. surveillance
- Special applications for avoiding exclusion of people in rural areas, or with special needs

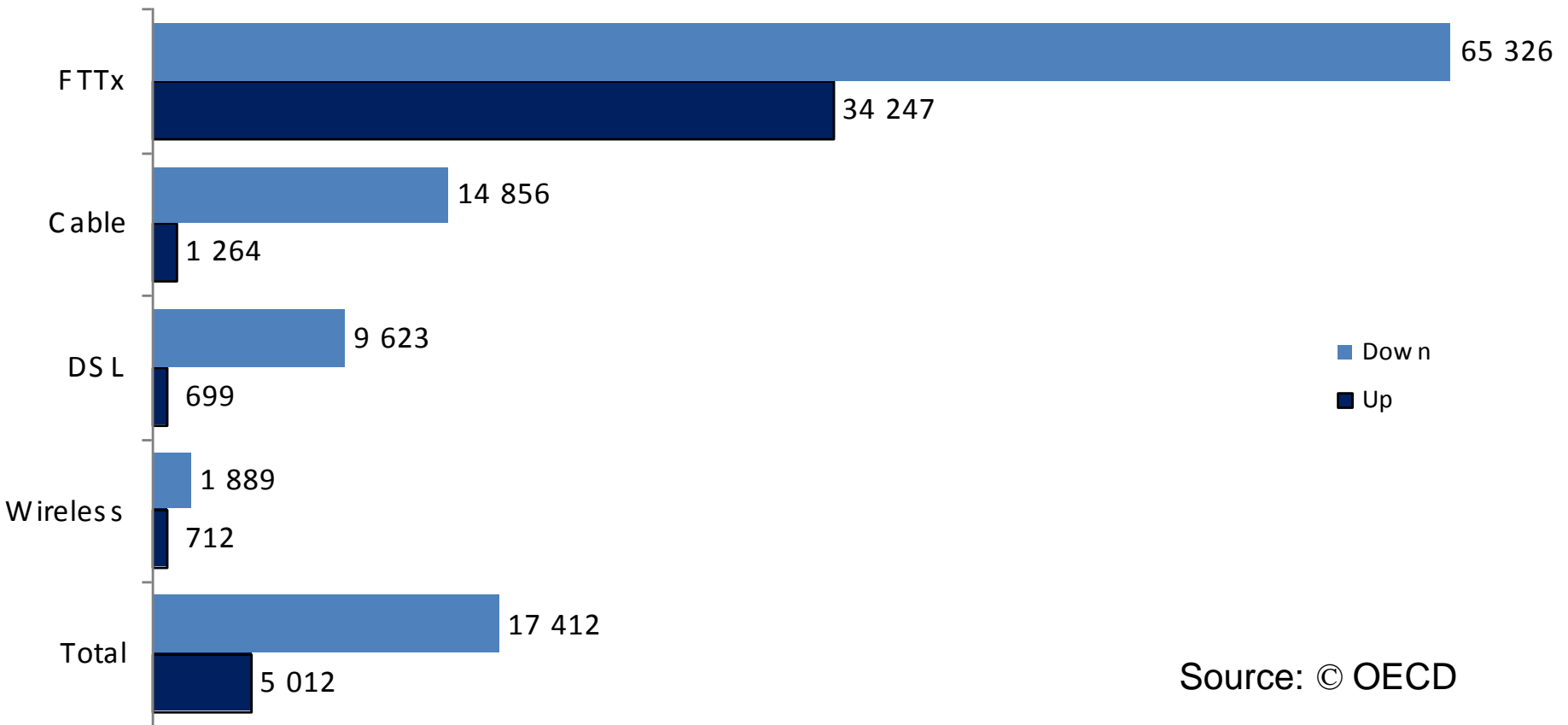
# Applications & Rates vs. Broadband Access Technologies

Source: © Planning



# OECD Average Advertized Broadband Speed per Technology: Sept. 2008

---



Source: © OECD

# Triple/Quad play

---

- Everybody has fixed telephony, TV, internet access for data
- Basic triple play is:
  - Voice, video, data in a single **bundle**, with a single bill
- Advanced triple play involves:
  - Equipment integration for customer and provider
  - Support of many devices (e.g. TV in PDAs)
  - User-friendly interfaces
  - Customization capabilities
  - Advanced service features
  - Advanced service software platform
- Quad play → Triple play + mobile telephony

# IPTV client

Source: © NetCentrex

- Easy User interface
- Personalization; e.g. Language selection, font size
- Parental Control
- Extendable Catalog System
  - Video on Demand
  - radio/TV/music/games
  - Simple navigation
  - Quality & admittances rating
- Browse Based Activities
  - TV-friendly web browsing
  - Bookmarks catalog
  - Gaming
  - ...
- Messaging



# Electronic program guide

**Programing Guide** 16:50

Select Reminder

- Only This Program
- This and Newer
- All Episodes

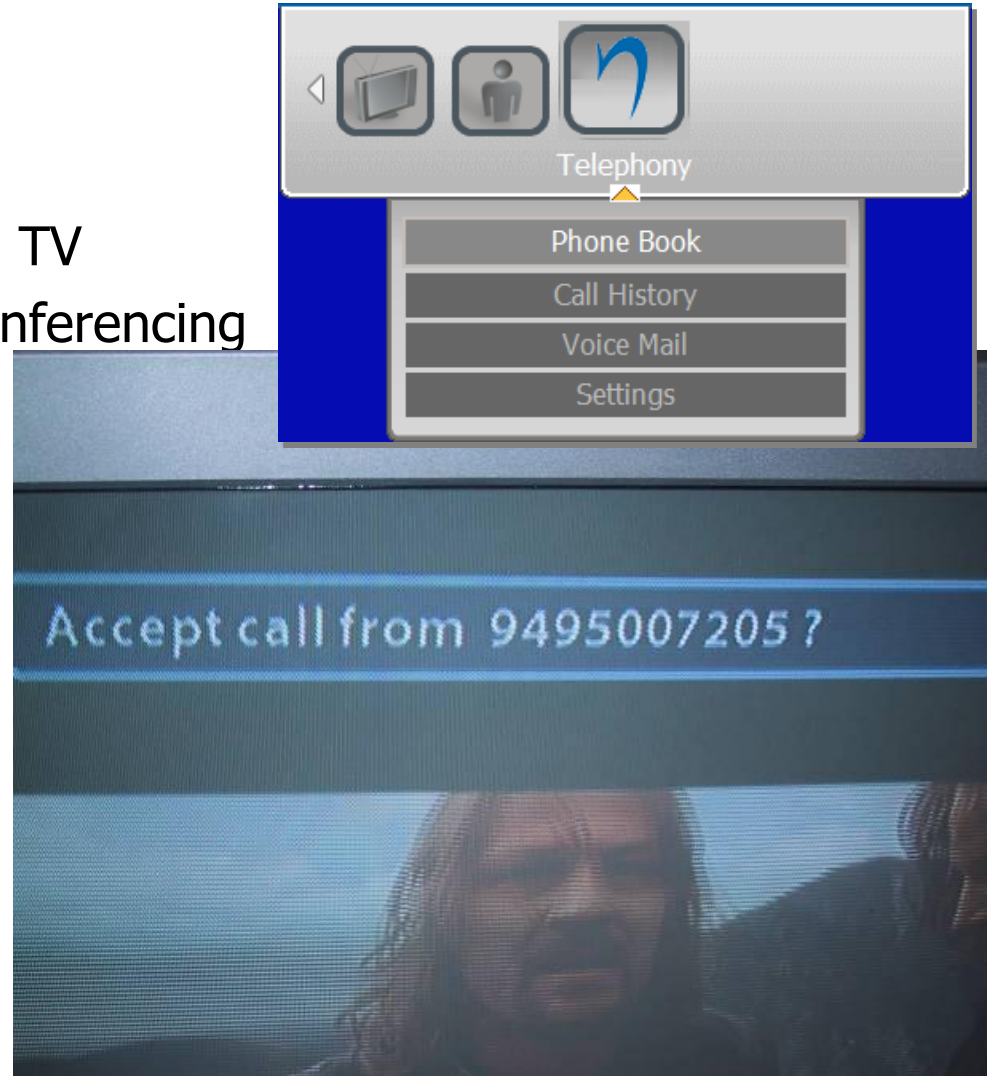
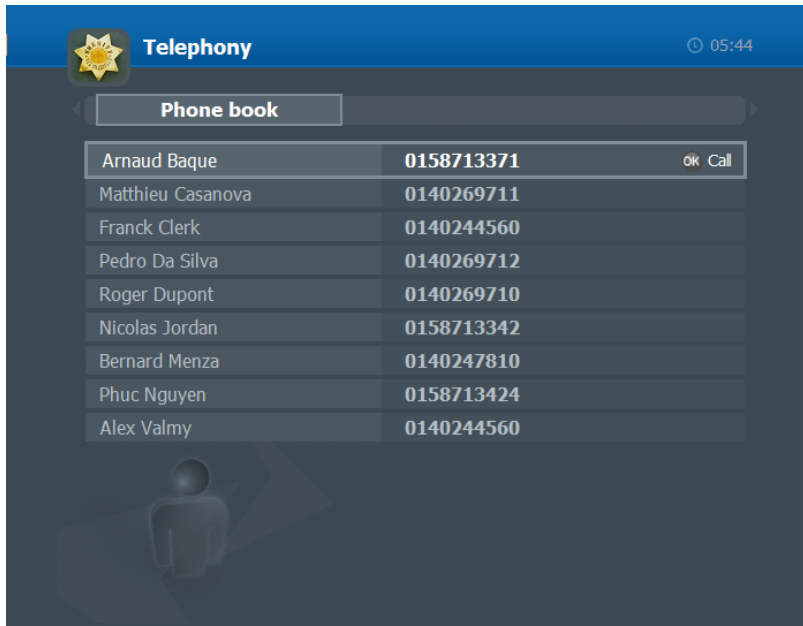
All Channels:	16:30	17:00	17:30	18:00
615. Cartoon Network	Foster's Home f	Camp Lazlo	Robotboy	Xiaolin Showdo
620. Boomerang	Camp Lazlo	What's New Sc	Tom & Jerry	Duck Dodgers
625. Trouble	Maybe It's Me	<b>My Wife and Kid</b>	My Wife and Kid	That '70s Show
701. Q / FHM	Battle Star			World's Most Im
705. The Box	You Control the	! Get the Lyric: You Control the		Breakers: Toda

More info Remind Date: Today

Source: © NetCentrex

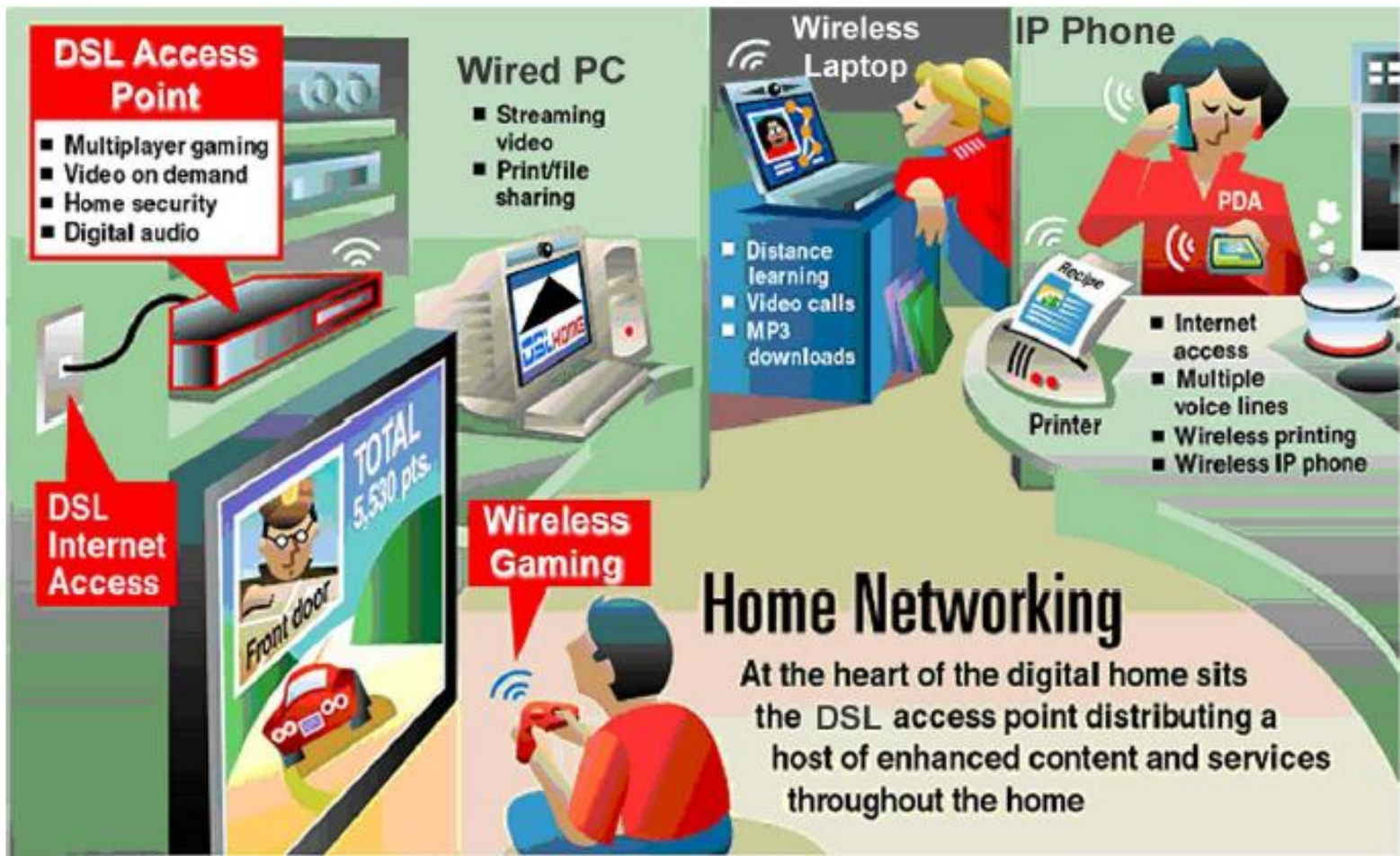
# Integrated triple play telephony

- Caller ID on TV
- Call history voice and video
- TV-based voice mail retrieval
- Message waiting indication on TV
- TV-based video calling and conferencing
- ...



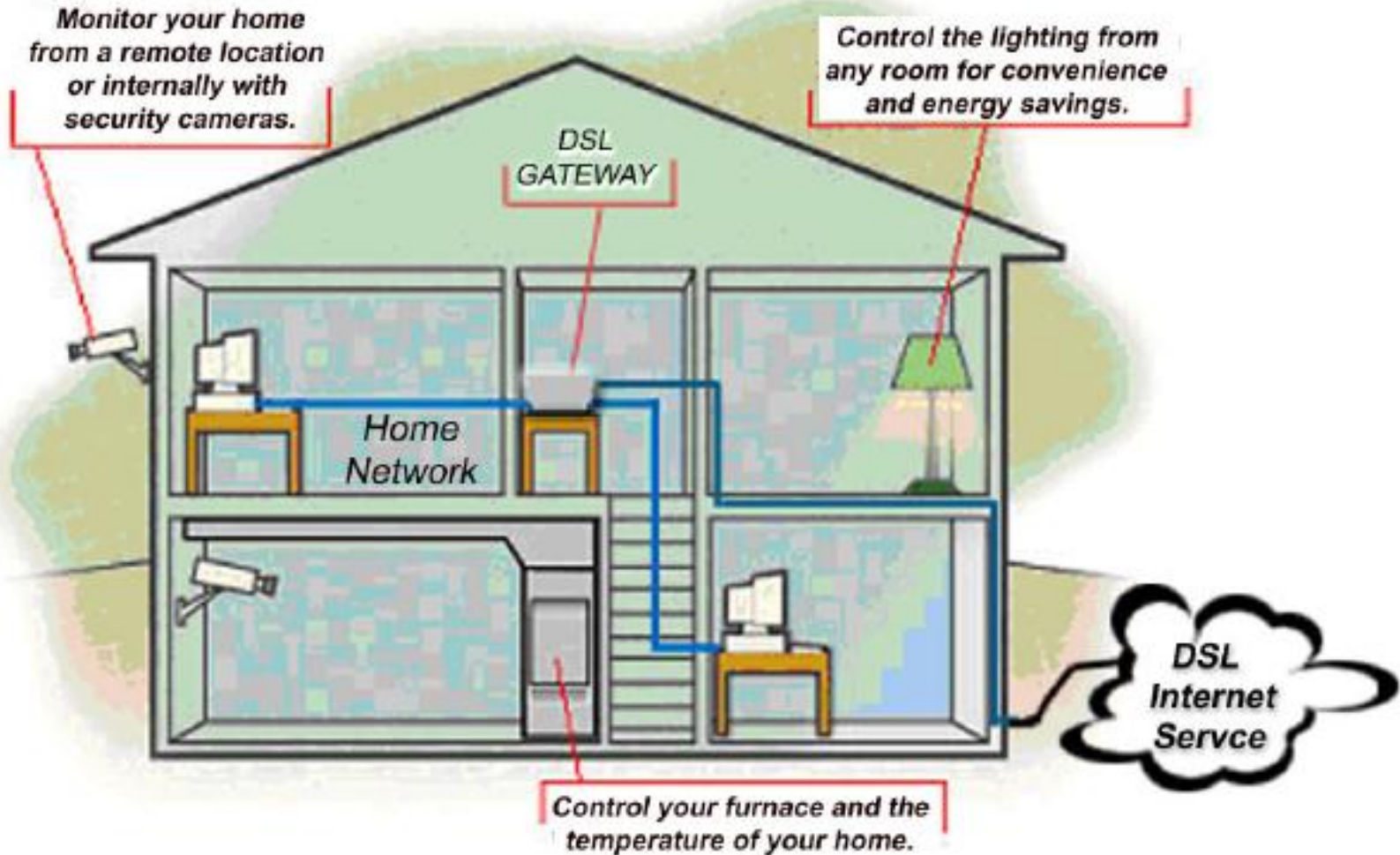
Source: © NetCentrex

# The overall picture: The digital home



Source: © DSL Forum

# A more “exotic” application: home monitoring



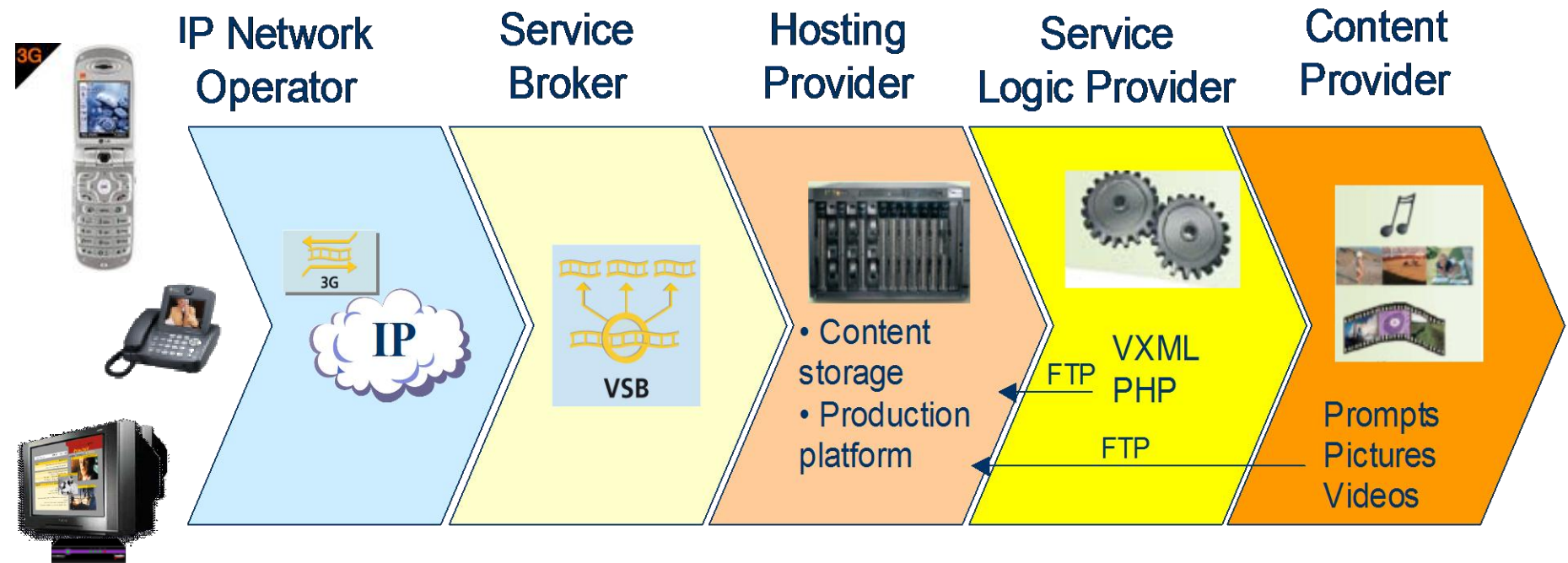
Source: © DSL Forum

# Value Chains for Broadband Applications

---

- Several players are involved in the provision of a broadband application
  1. Value-adding players, delivering the content and transforming it to bits
  2. ISP, network infrastructure provider etc, delivering the bits
- Variety of interactions and business relations

# The Value chain for Video on Demand



Source: © NetCentrex

---

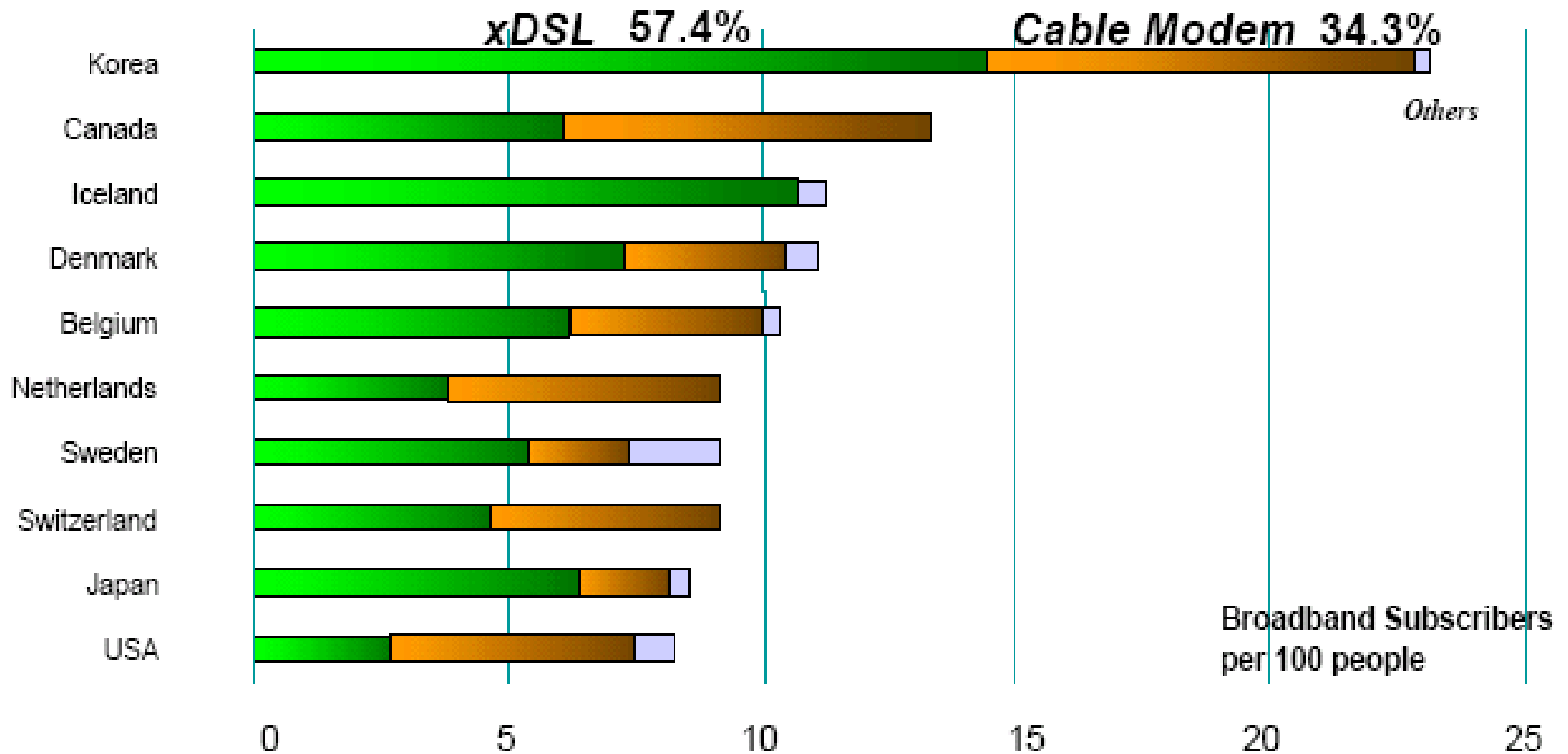
# Broadband Markets

# Introduction

---

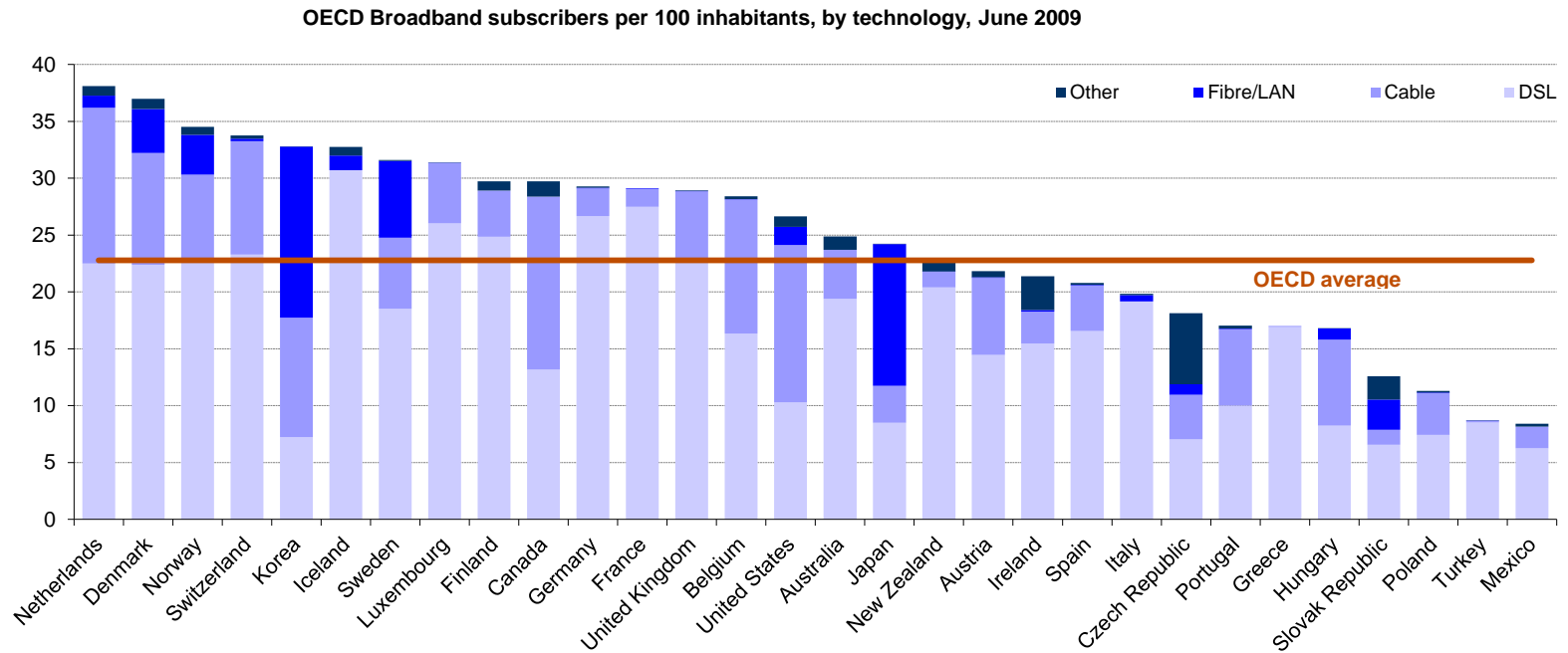
- Broadband applications are here
- Access technologies are continuously evolving:
  - Applications become faster and more demanding
- But how about **demand**?
  - For broadband access
  - For applications
- What is the impact of prices?

# The top countries worldwide: June 2003



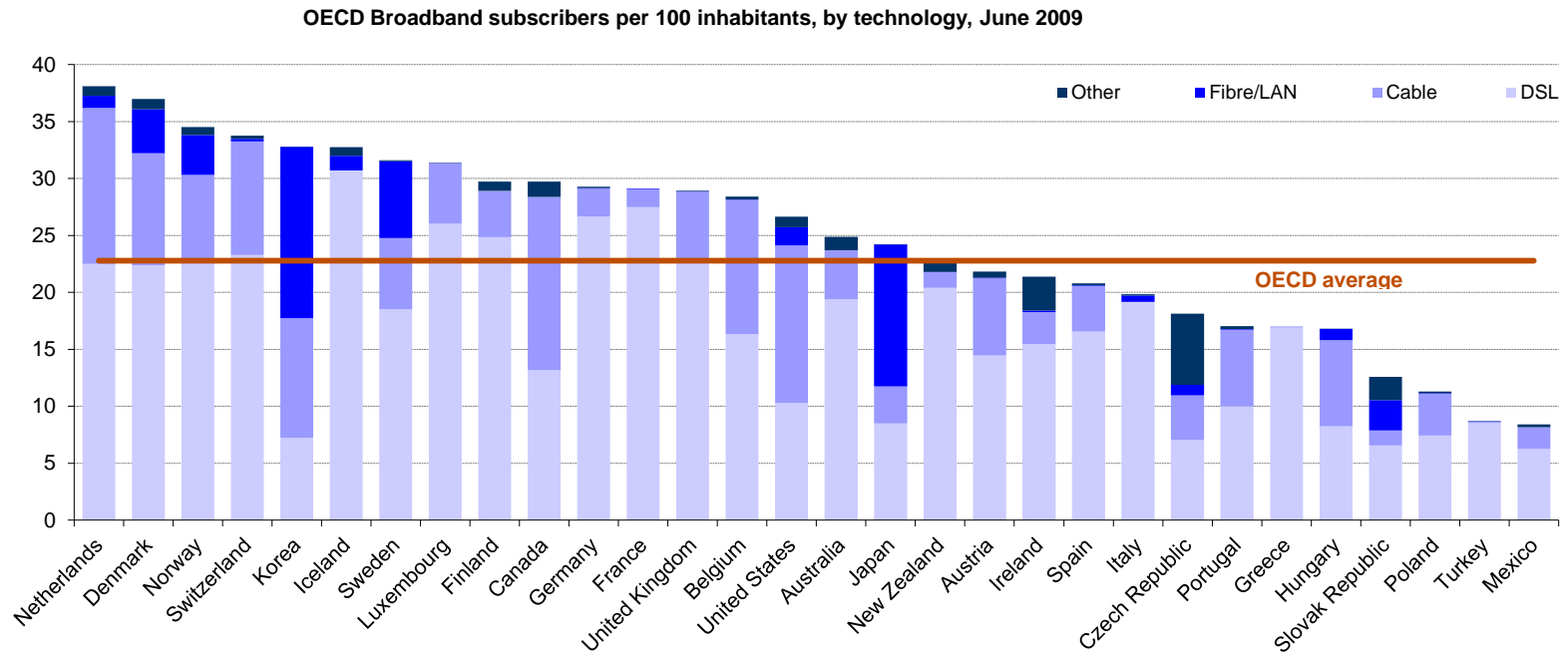
Source: OECD, 2004. (As of Jun. 2003)

# The top countries worldwide: Dec. 2008



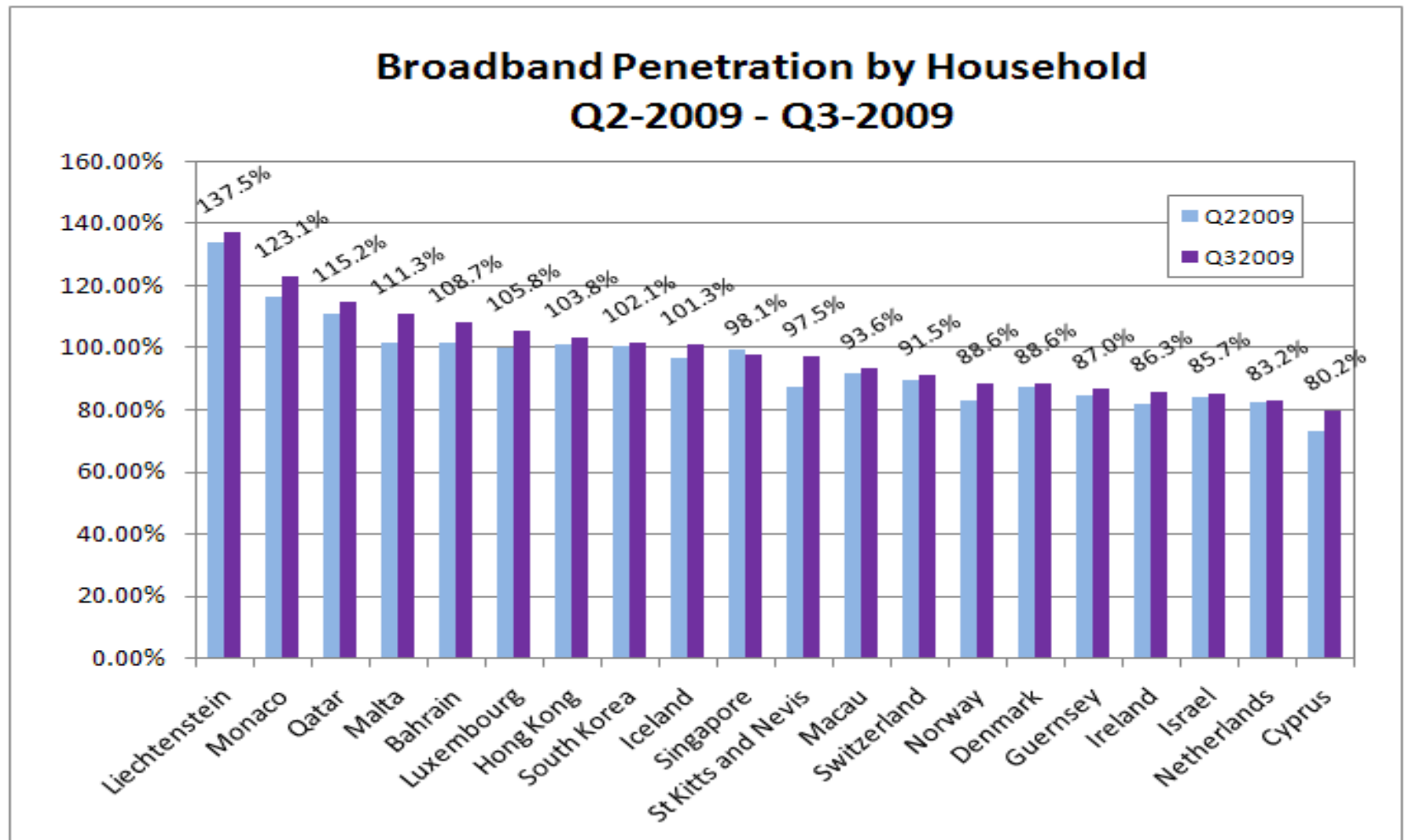
Source: OECD

# The top countries worldwide: June. 2009



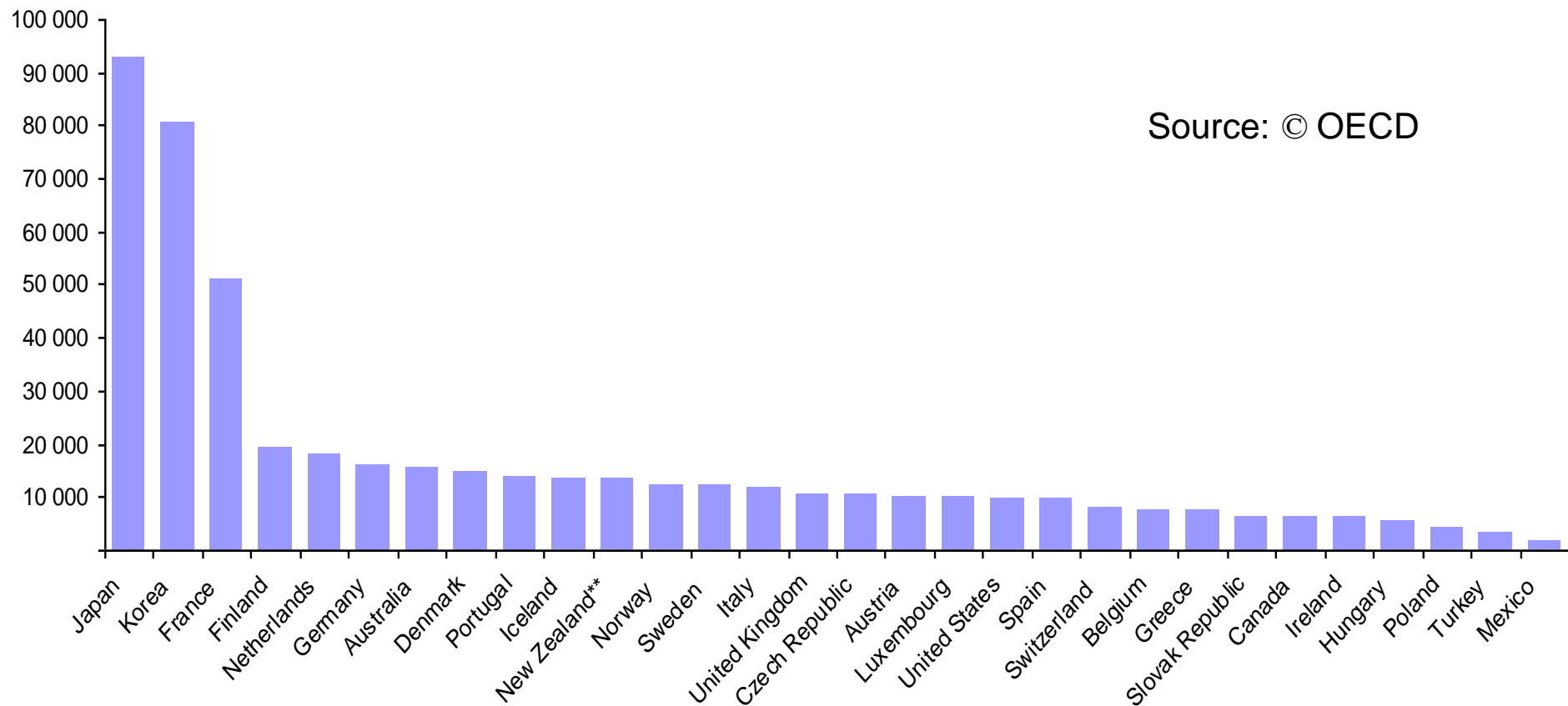
Source: OECD

# Top countries worldwide by household



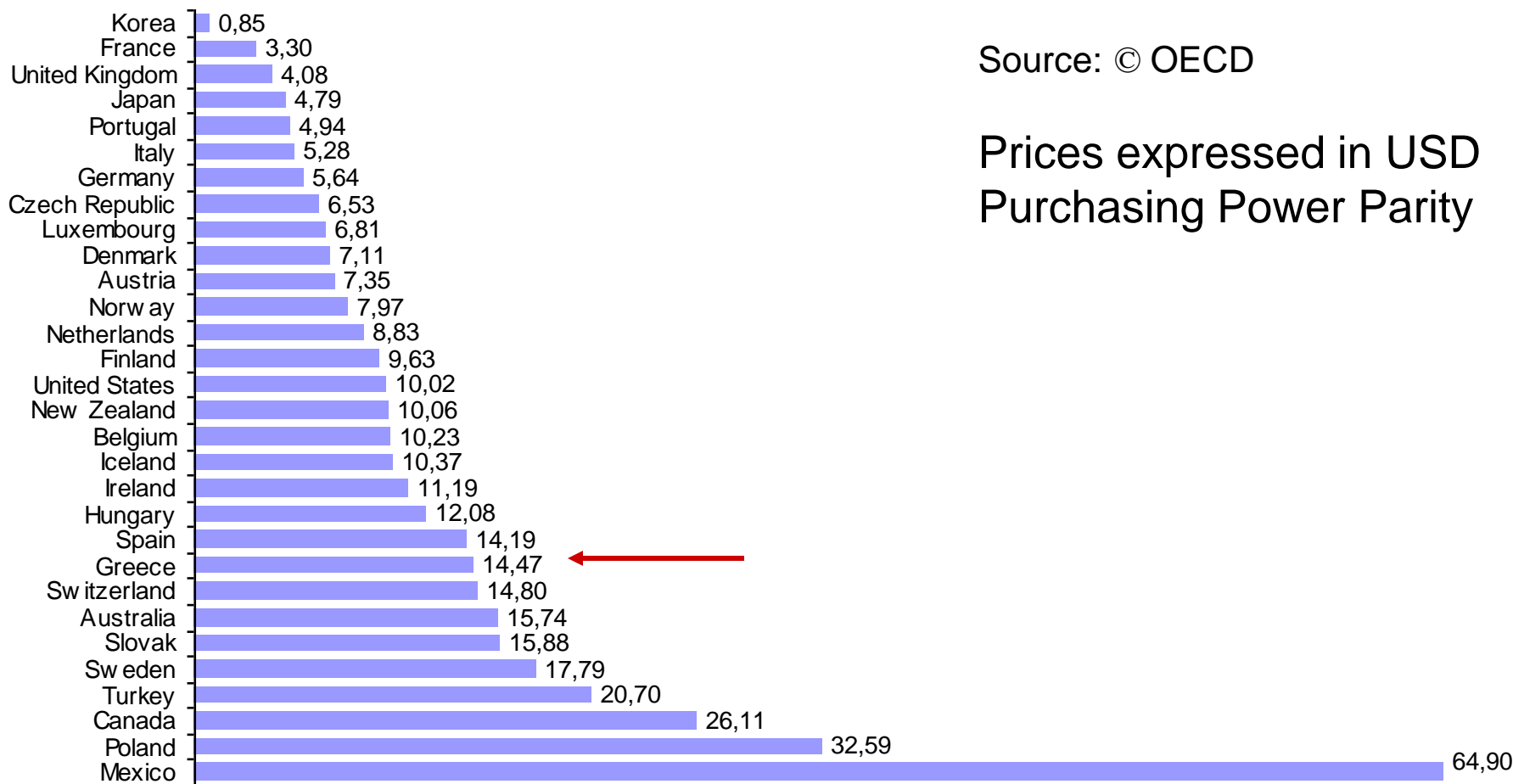
# Different speeds per country: Sept. 2008

Average advertised broadband download speed, by country, kbit/s, September 2008



# Average price per country per advertized Mbps: Oct. 2008

Average broadband monthly price per advertised Mbit/s, Oct 2008, USD PPP

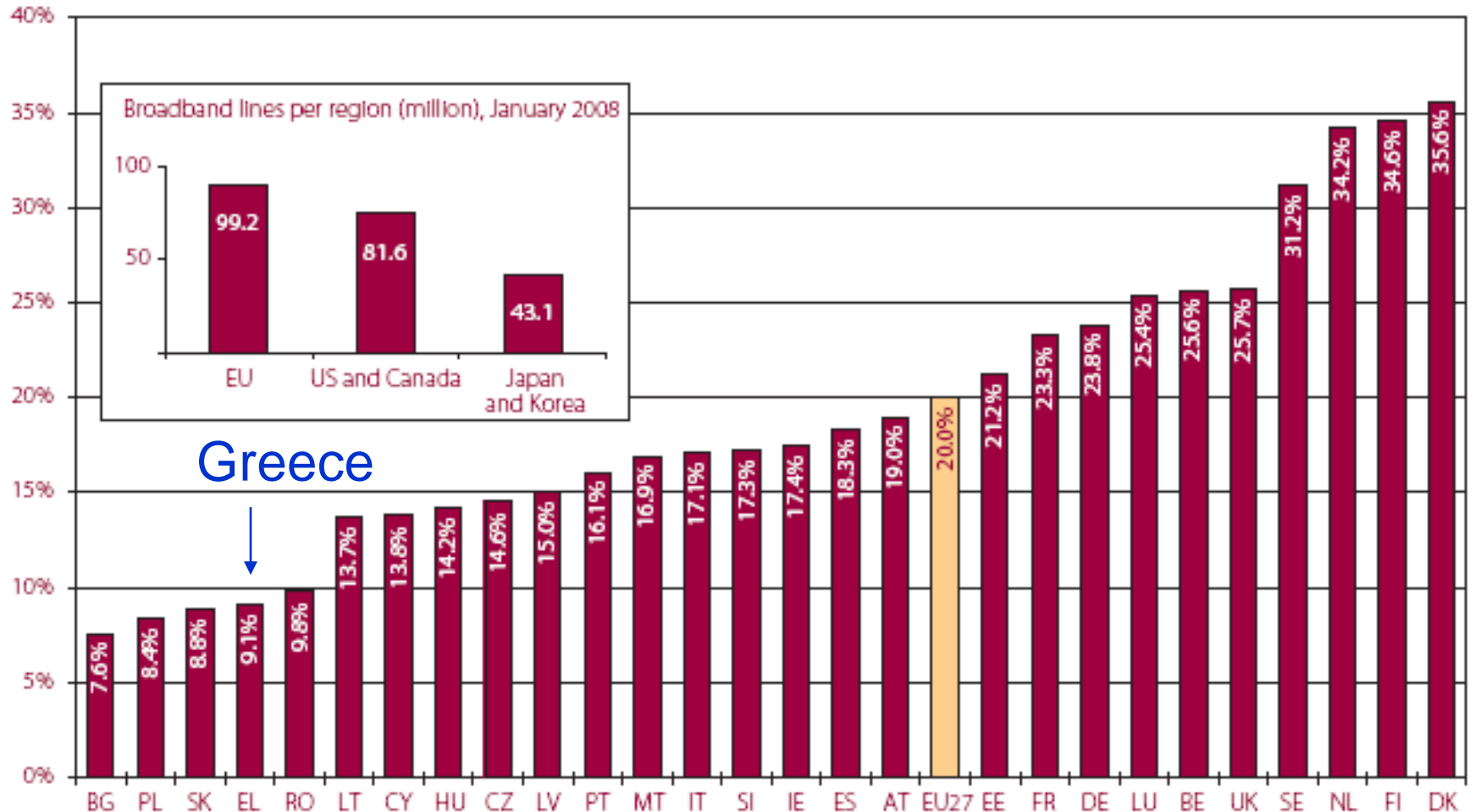


Source: © OECD

Prices expressed in USD  
Purchasing Power Parity

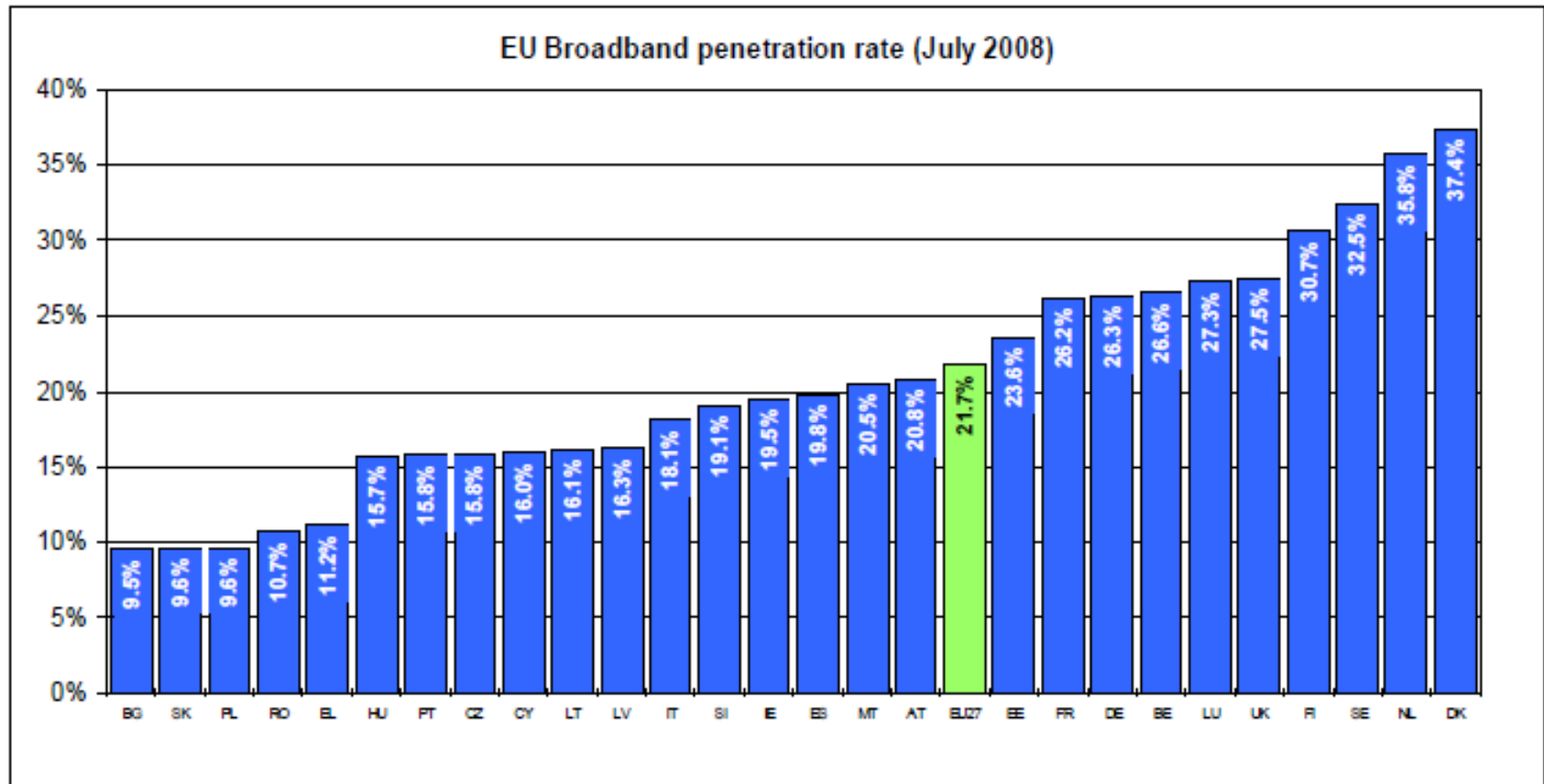
# Broadband Penetration in EU-27 (Jan. 2008)

Graph 1: **EU Broadband penetration rate (January 2008)**



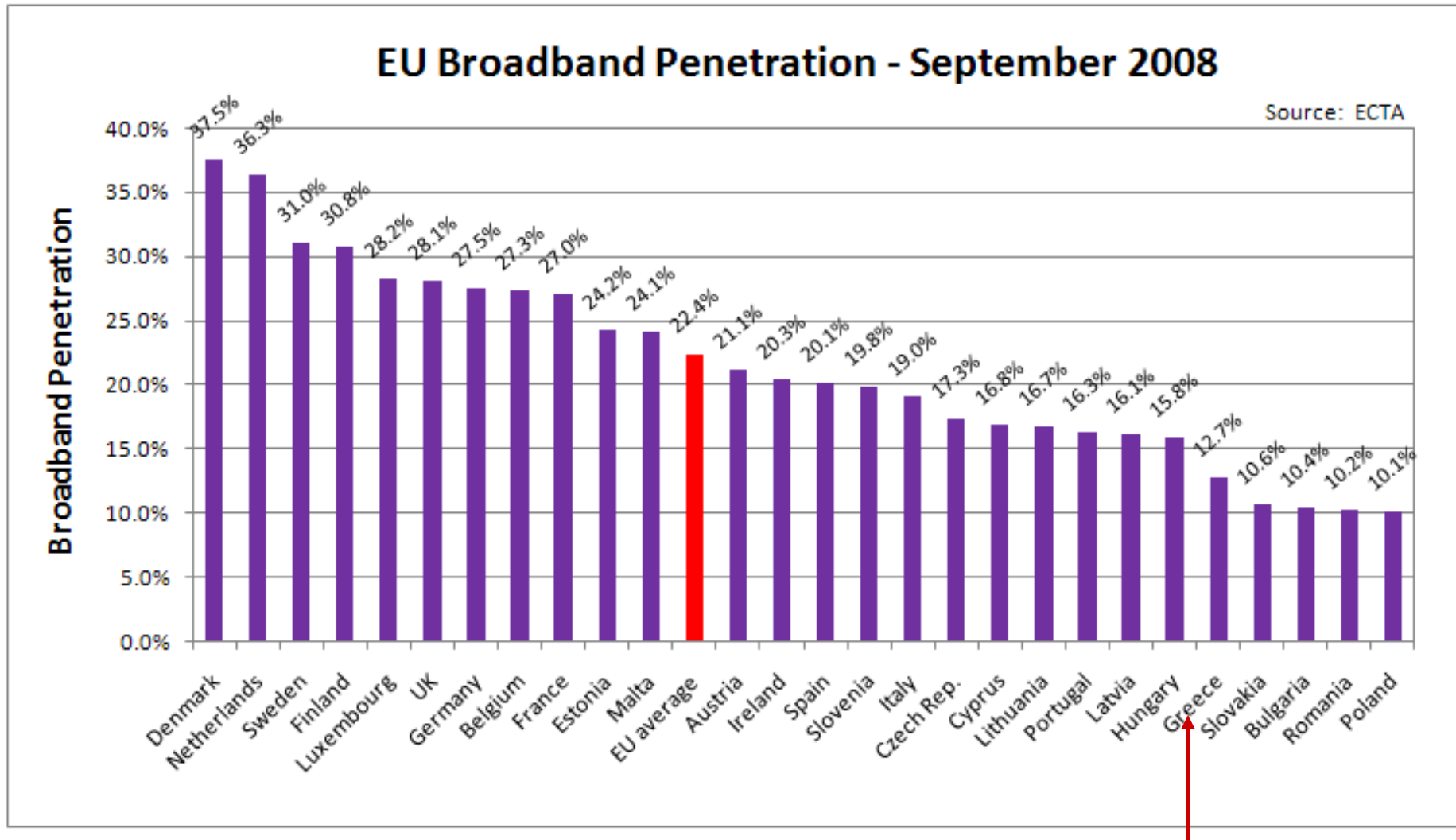
Source: Commission services. Data for FR, NL, AT, EE and LT refer to October 2007.

# Broadband Penetration in EU-27 (Jul. 2008)

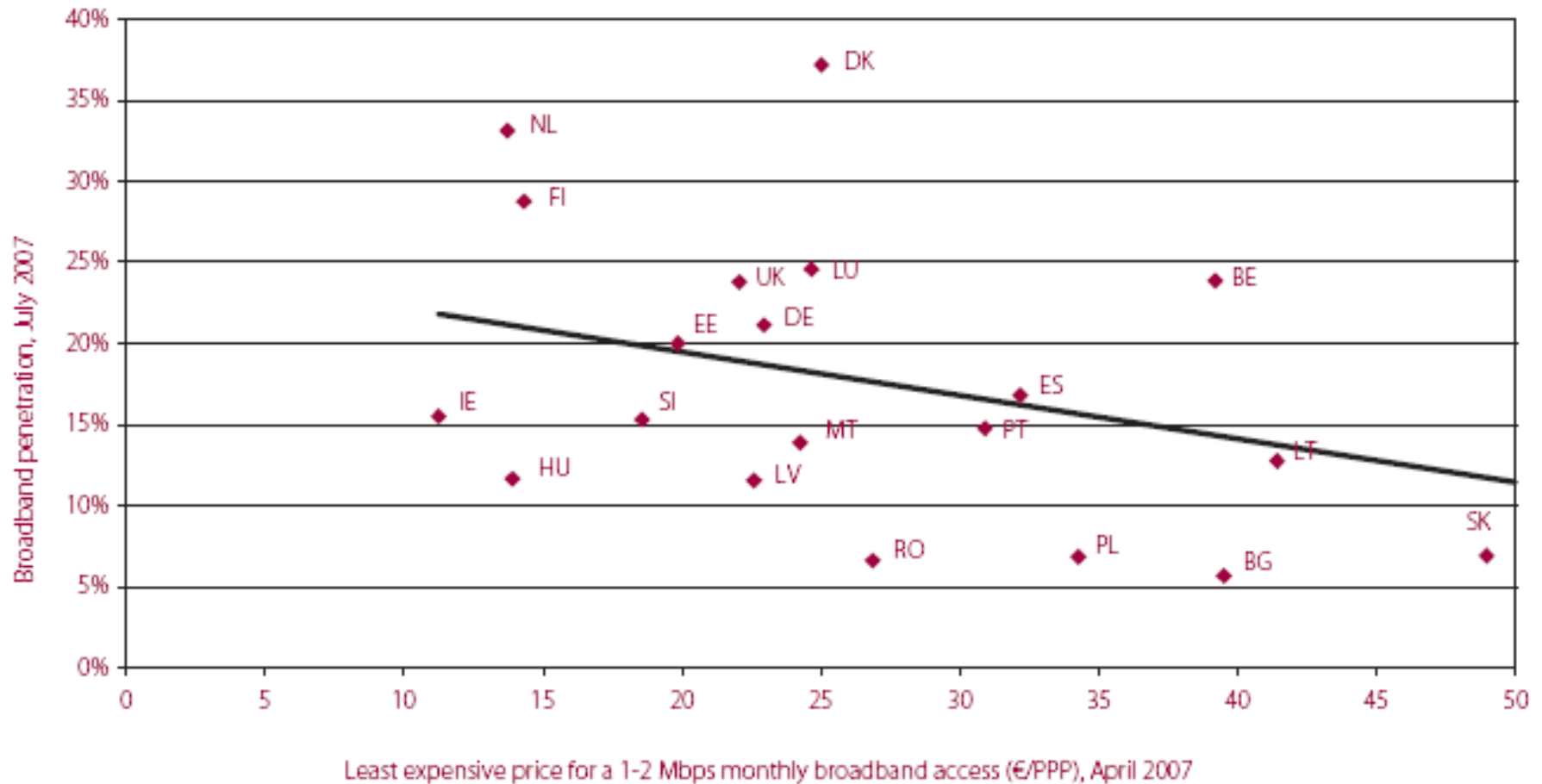


Source: European Commission COCOM08-41 FINAL

# Broadband Penetration in EU-27 (Sept. 2008)

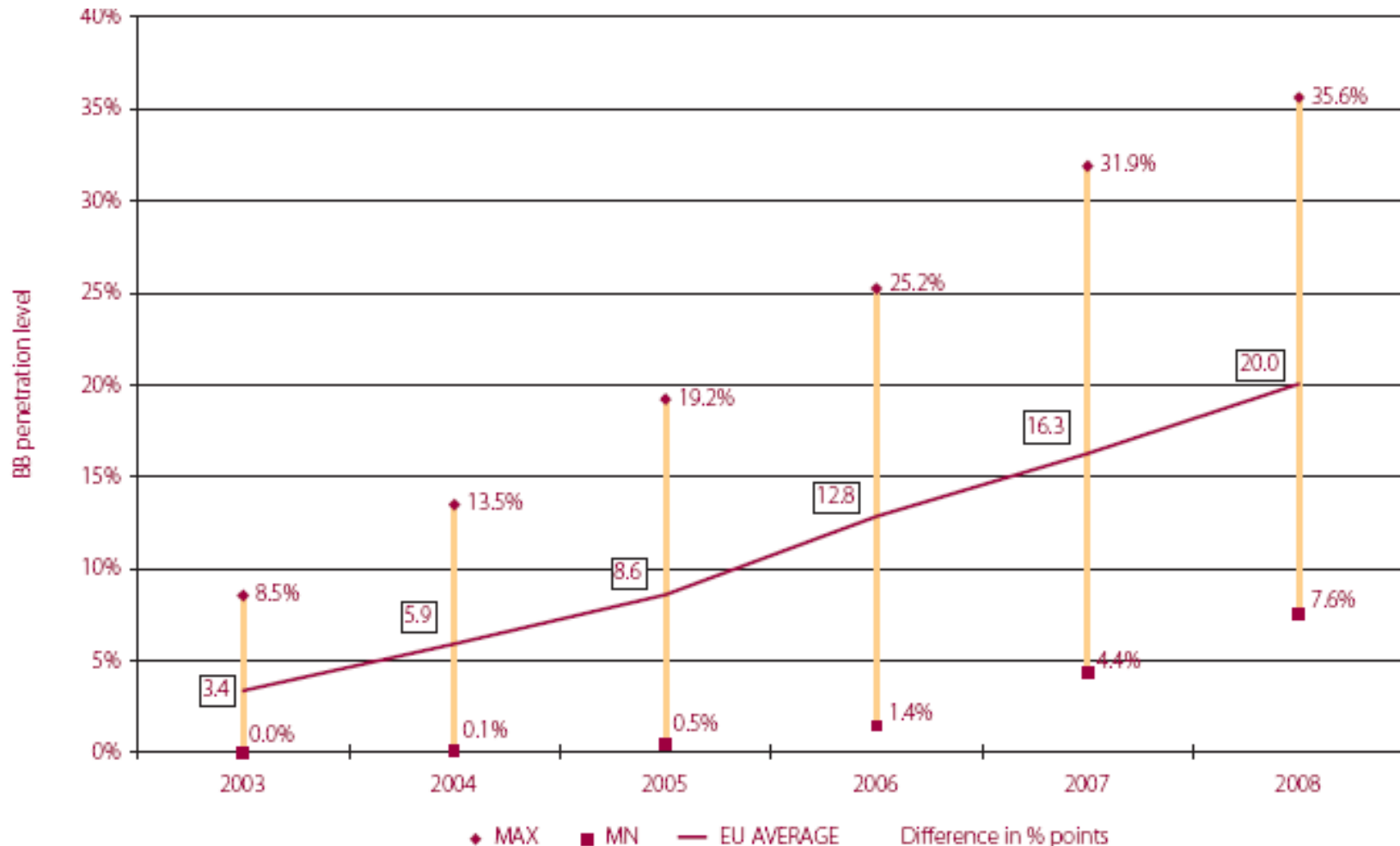


# Correlation of Prices and Broadband penetration in EU (July 2007)



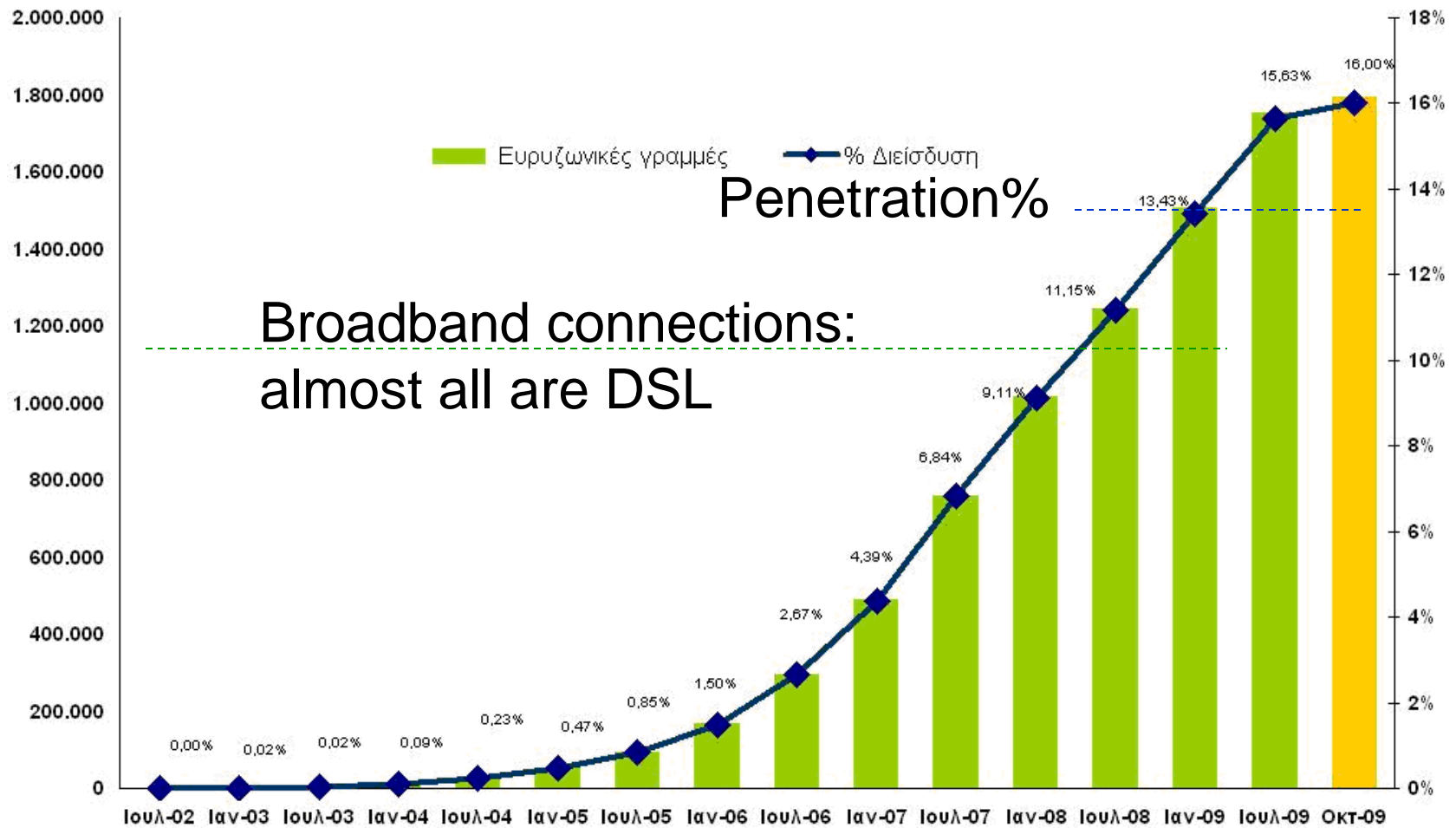
Source: EC services based on data from COCOM and Van Dijk  
EL, CY: out of scale. Data on prices for AT, CZ, IT, FR and SE not available.

# Gap in Broadband penetration in EU (2003 to 2008)



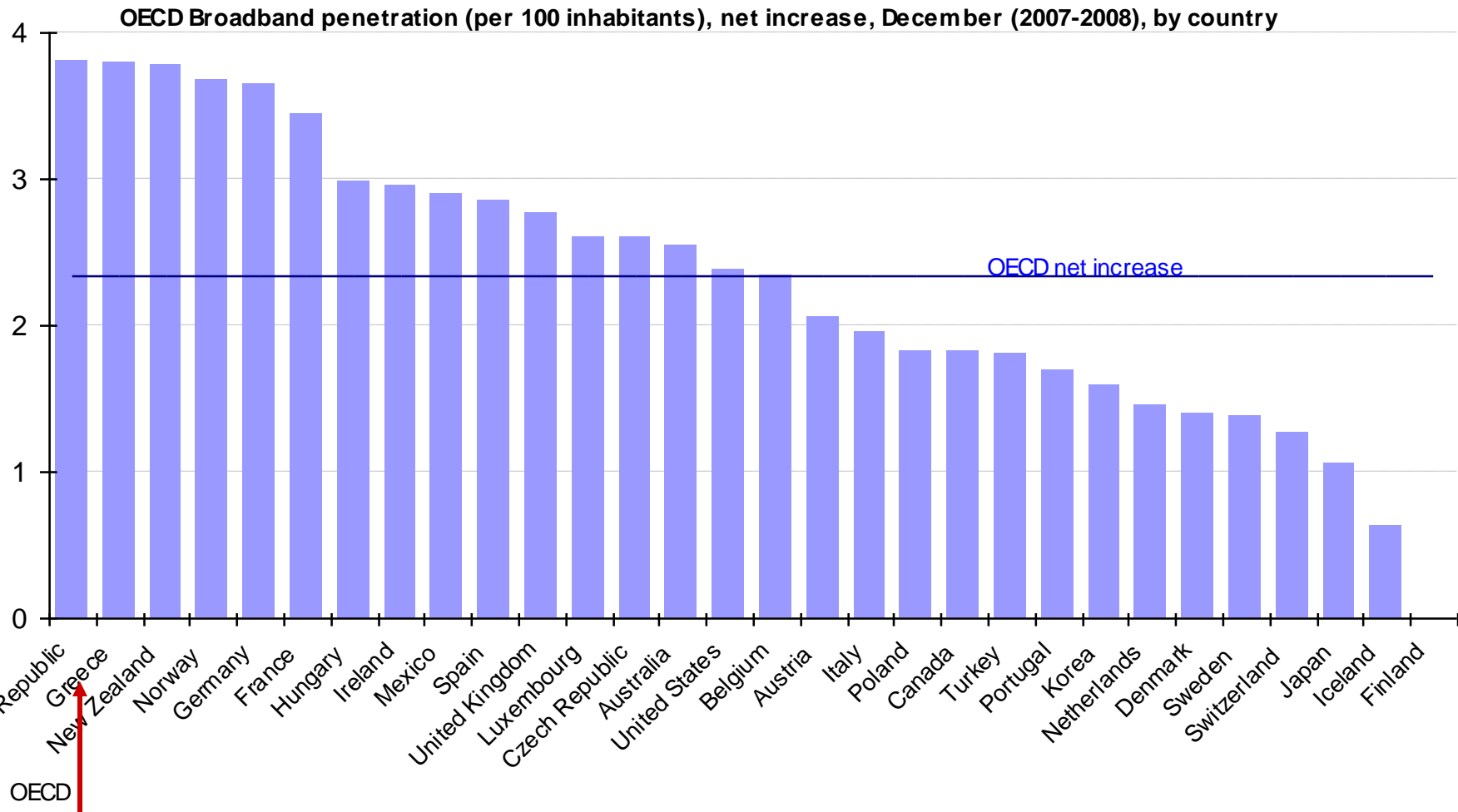
Source: EC services based on COCOM data

# Broadband Penetration in Greece (July 2002 to Oct. 2009)

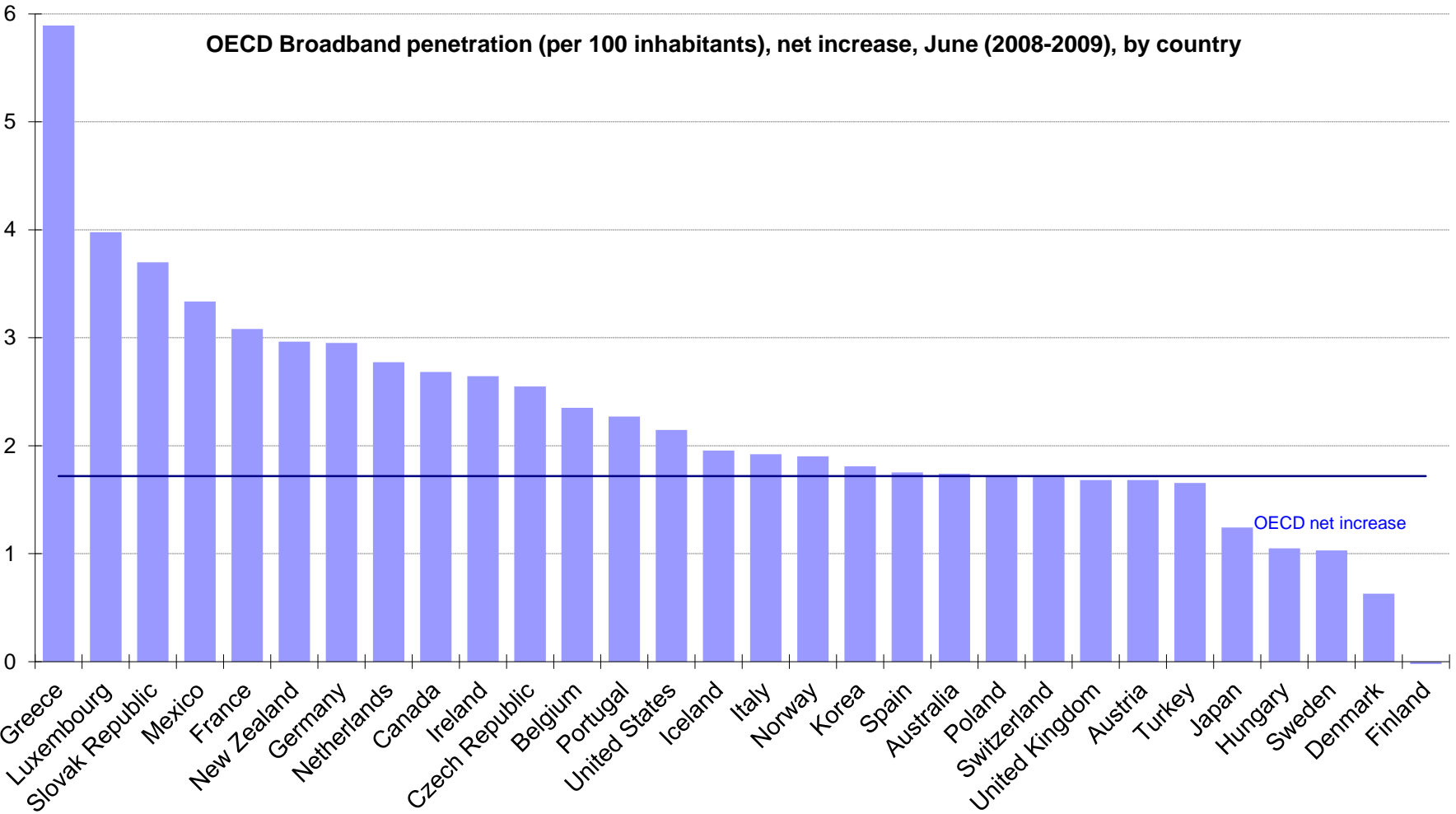


Source: © observatory.gr

# Rate of yearly increase of broadband penetration (Dec. 2007 - 2008)

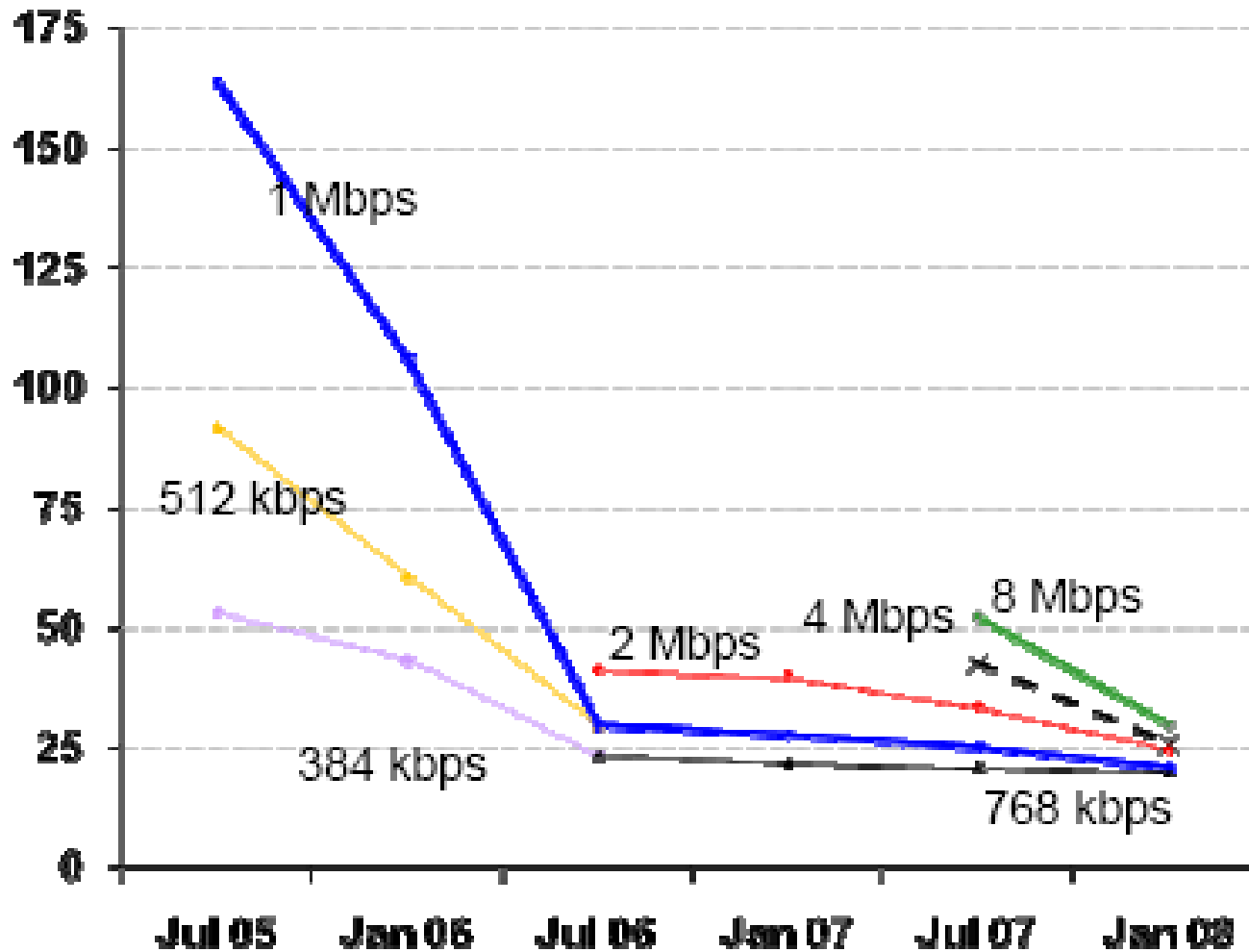


# Rate of yearly increase of broadband penetration (June. 2008 - 2009)

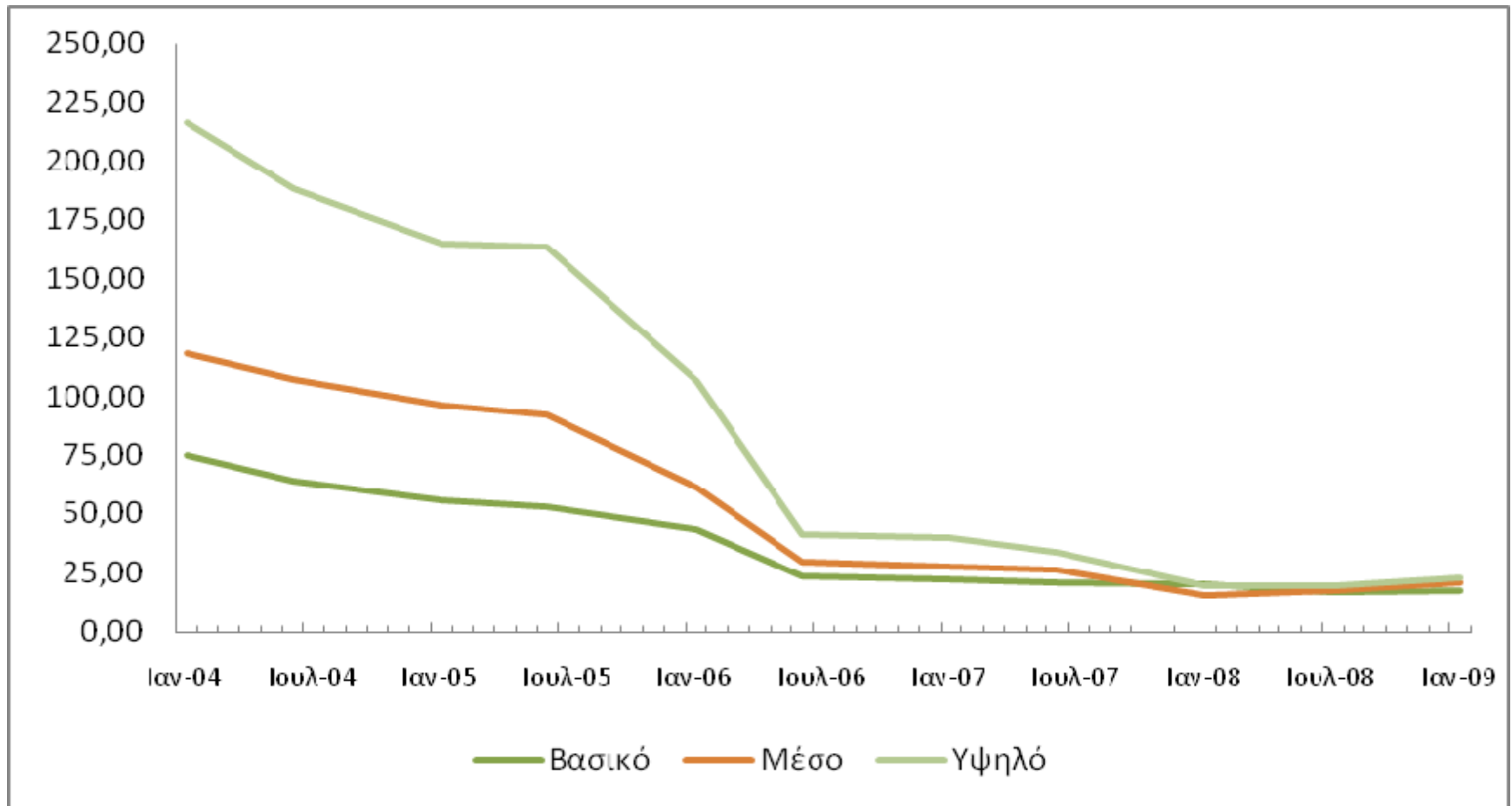


Source : OECD

# Evolution of Prices in Greece

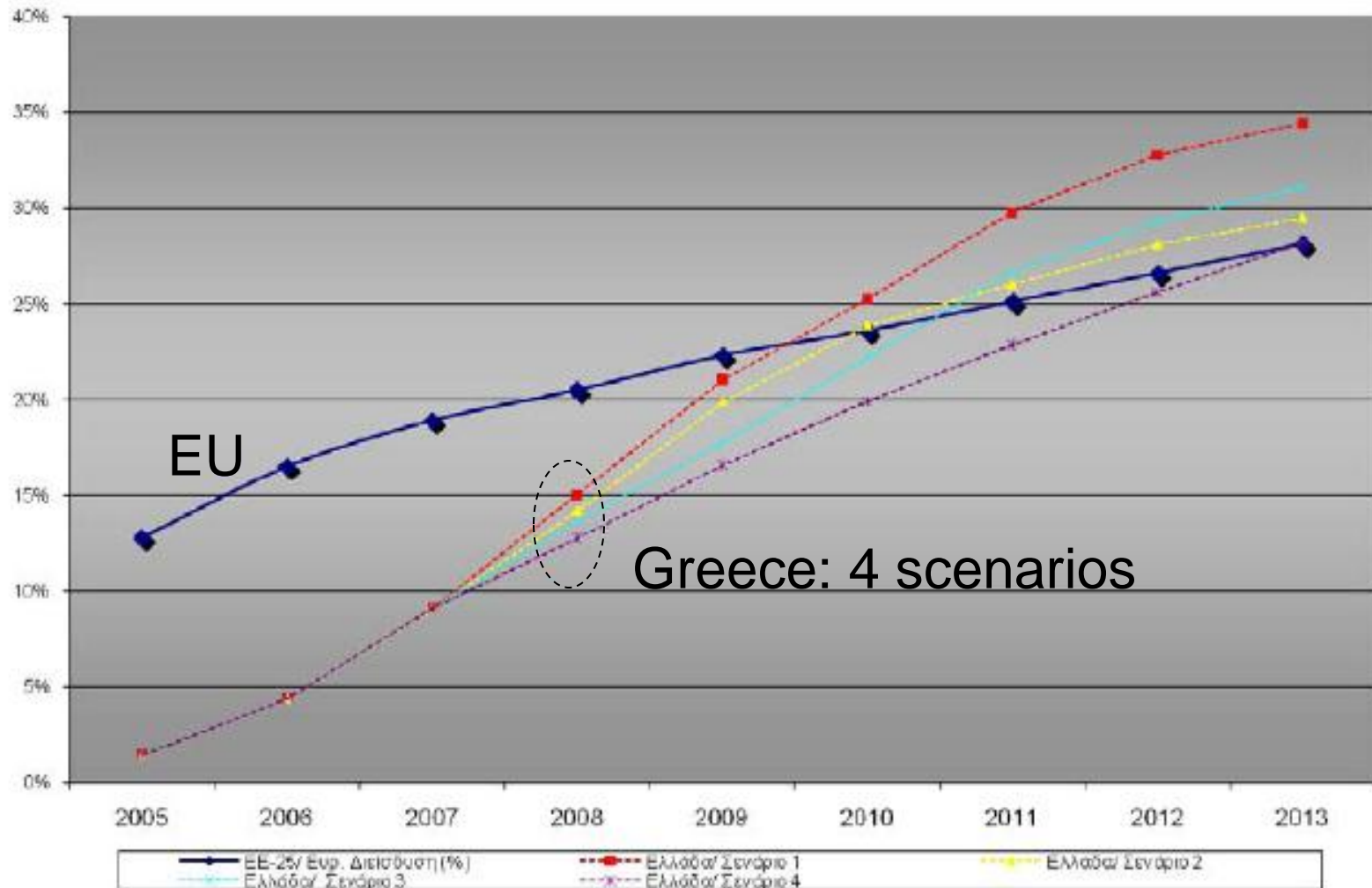


# Evolution of Prices in Greece



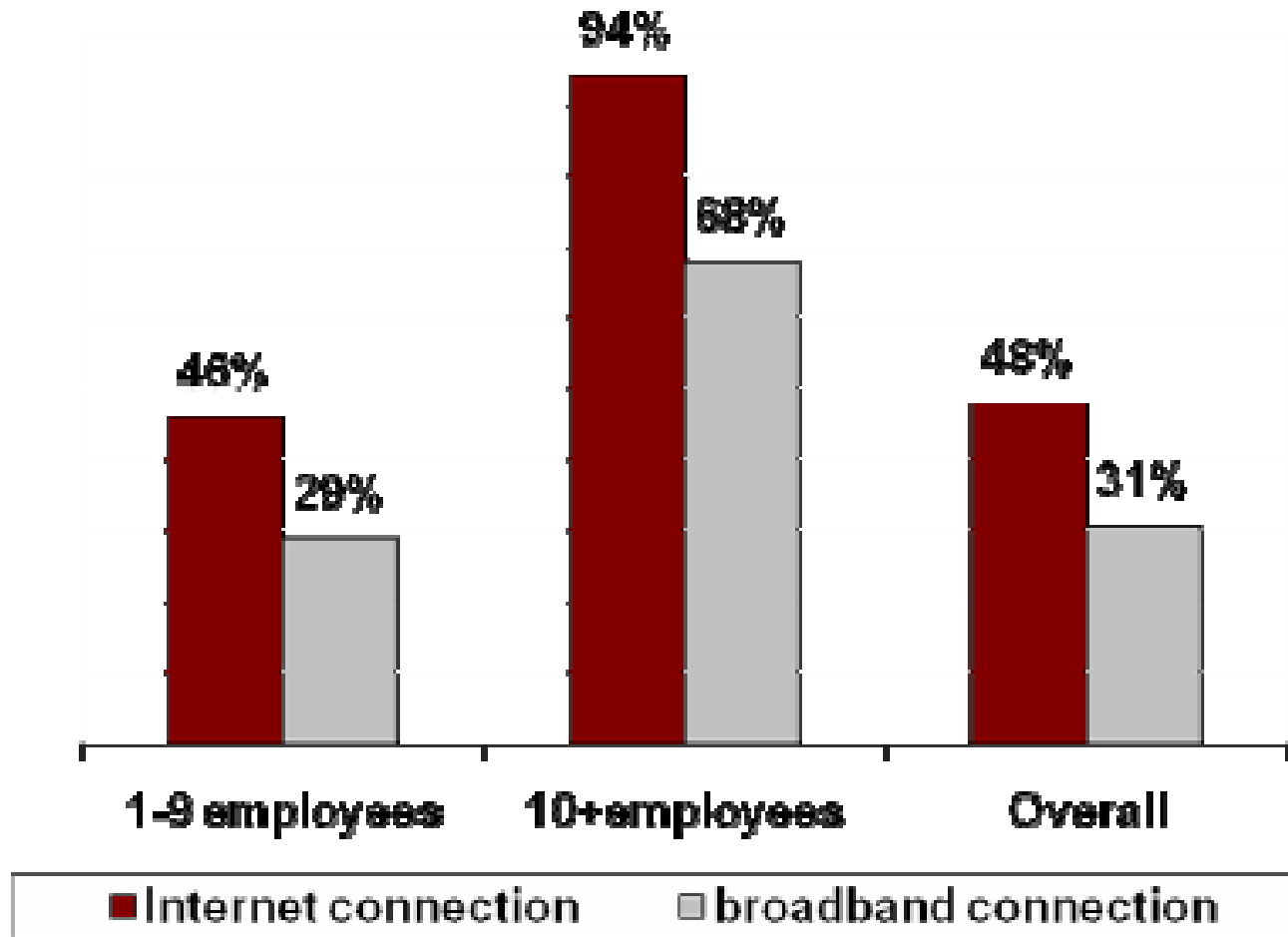
Source: © observatory.gr

# Digital Convergence of Greece with EU



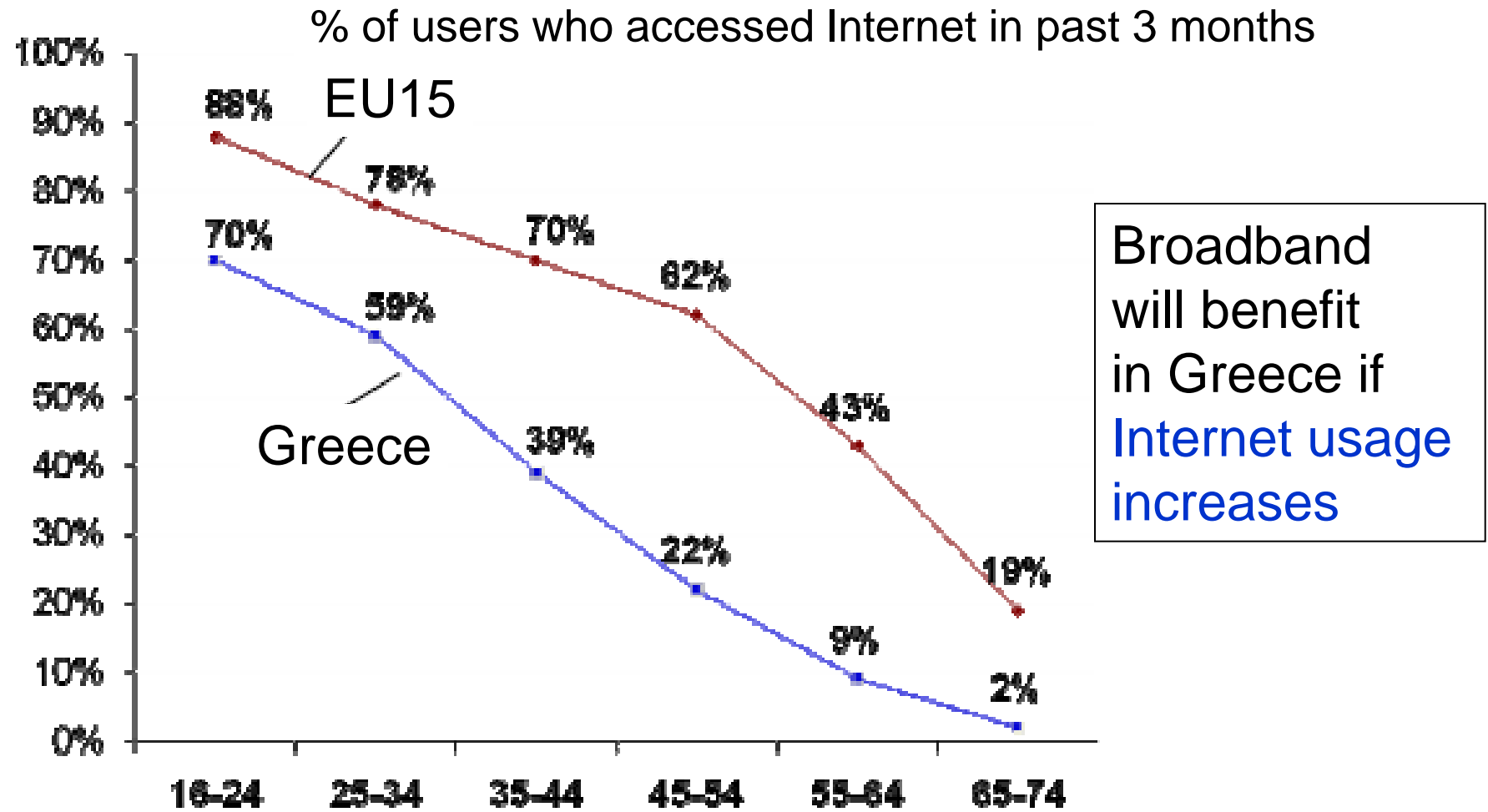
Source: © observatory.gr

# Internet and broadband penetration in Greek businesses (Dec. 2007)



Sources: © Eurostat, observatory.gr, A.T.Kearney

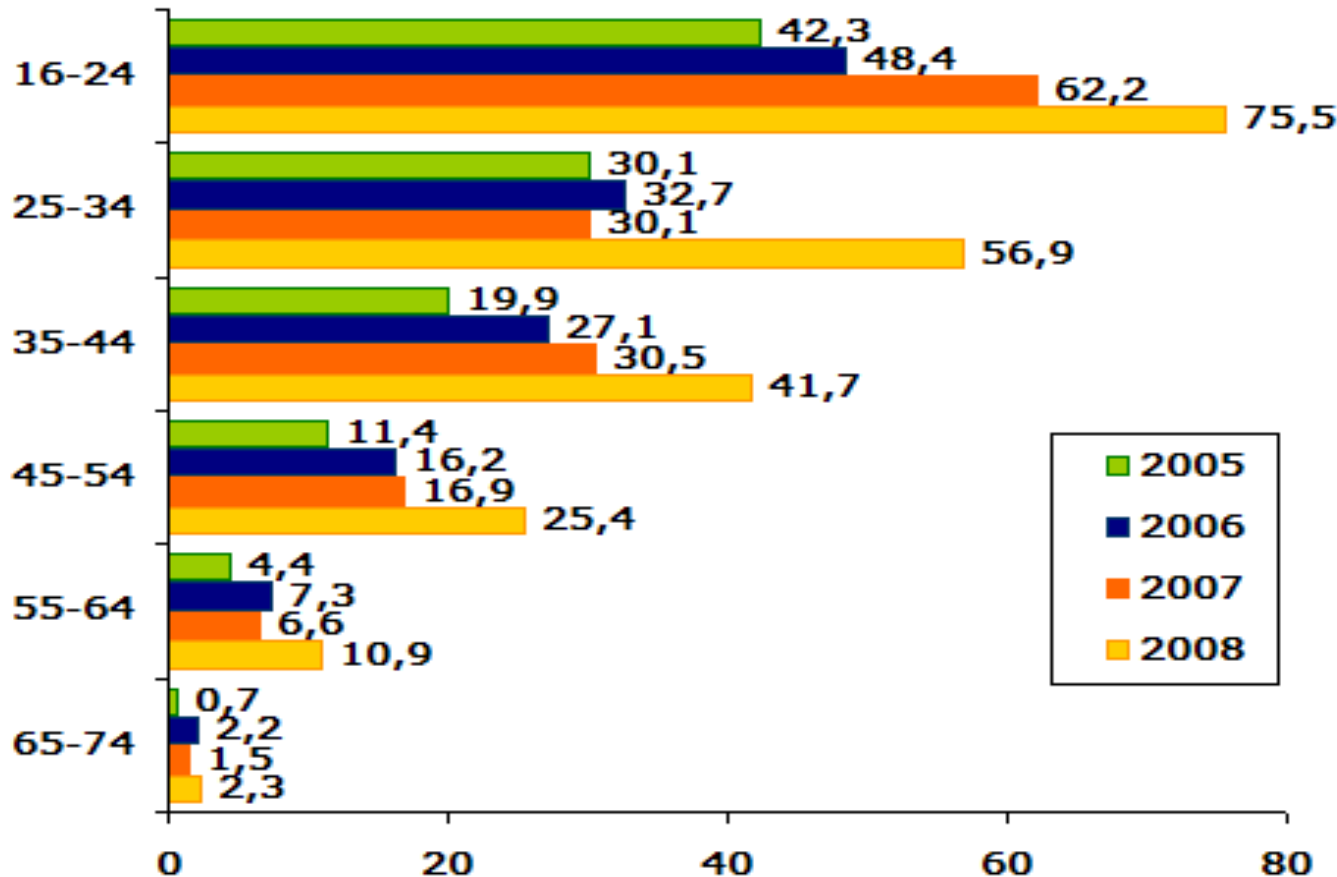
# Internet penetration in Greek users (Dec. 2007)



Sources: © Eurostat, observatory.gr, A.T.Kearney

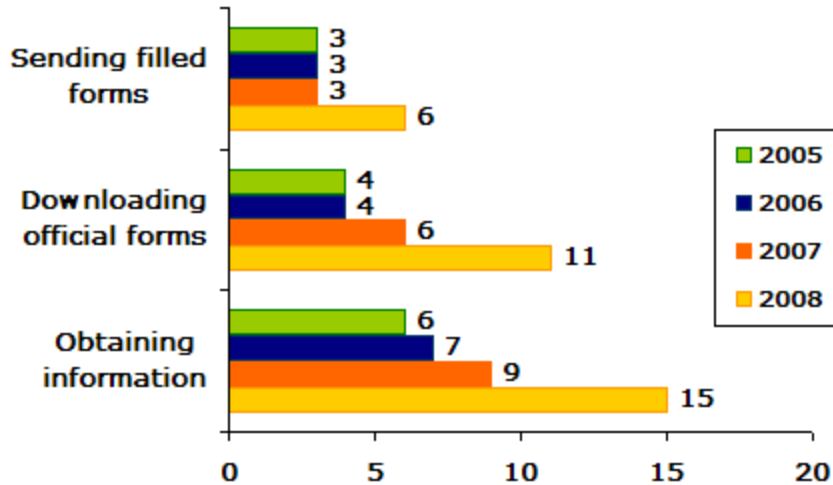
# Percentage of individuals regularly using the Internet by age

at least once a week over the last 3 months of 2008

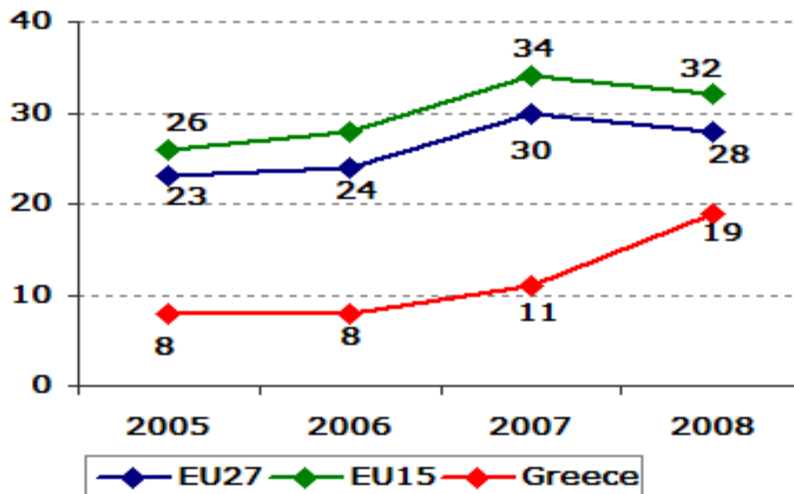


Source: © observatory.gr

# 19% of individuals using the Internet for interacting with public authorities



**% of individuals in Greece using the Internet for interacting with public authorities broken down by purpose**



**% of individuals using the Internet for interacting with public authorities**

Increasing trend in the rate of individuals interacting with public authorities in Greece in comparison to the EU average

Source: © observatory.gr