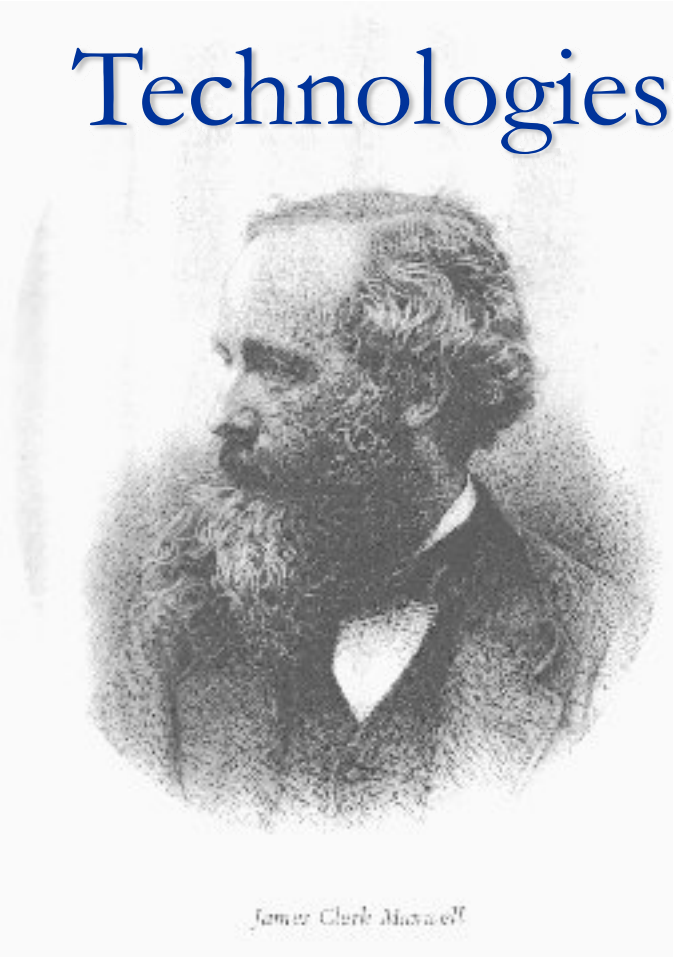
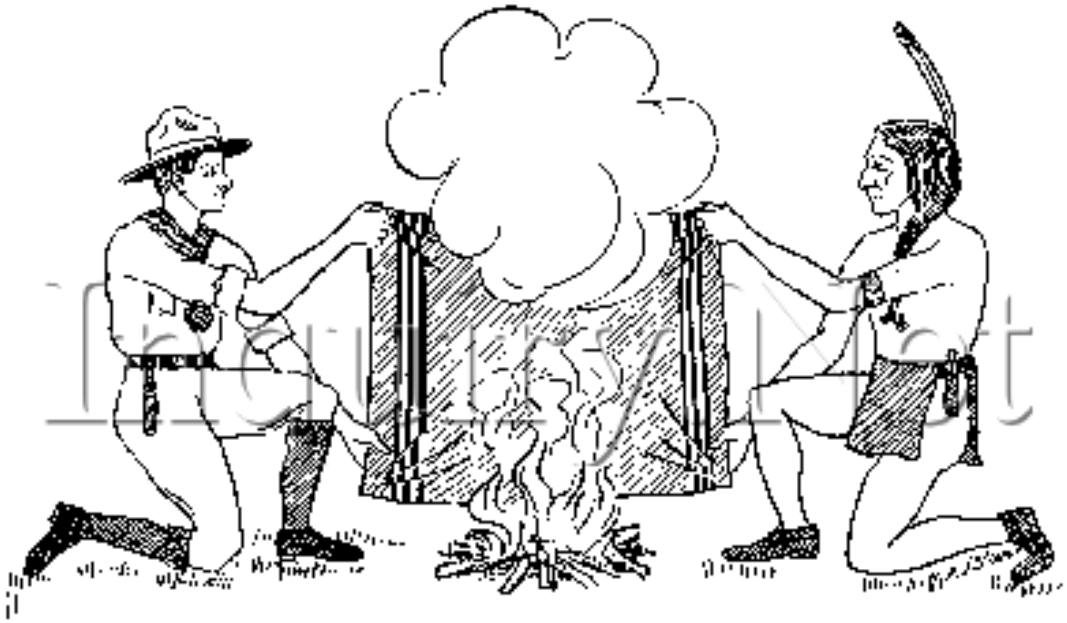
工程與生活

Wireless Technologies



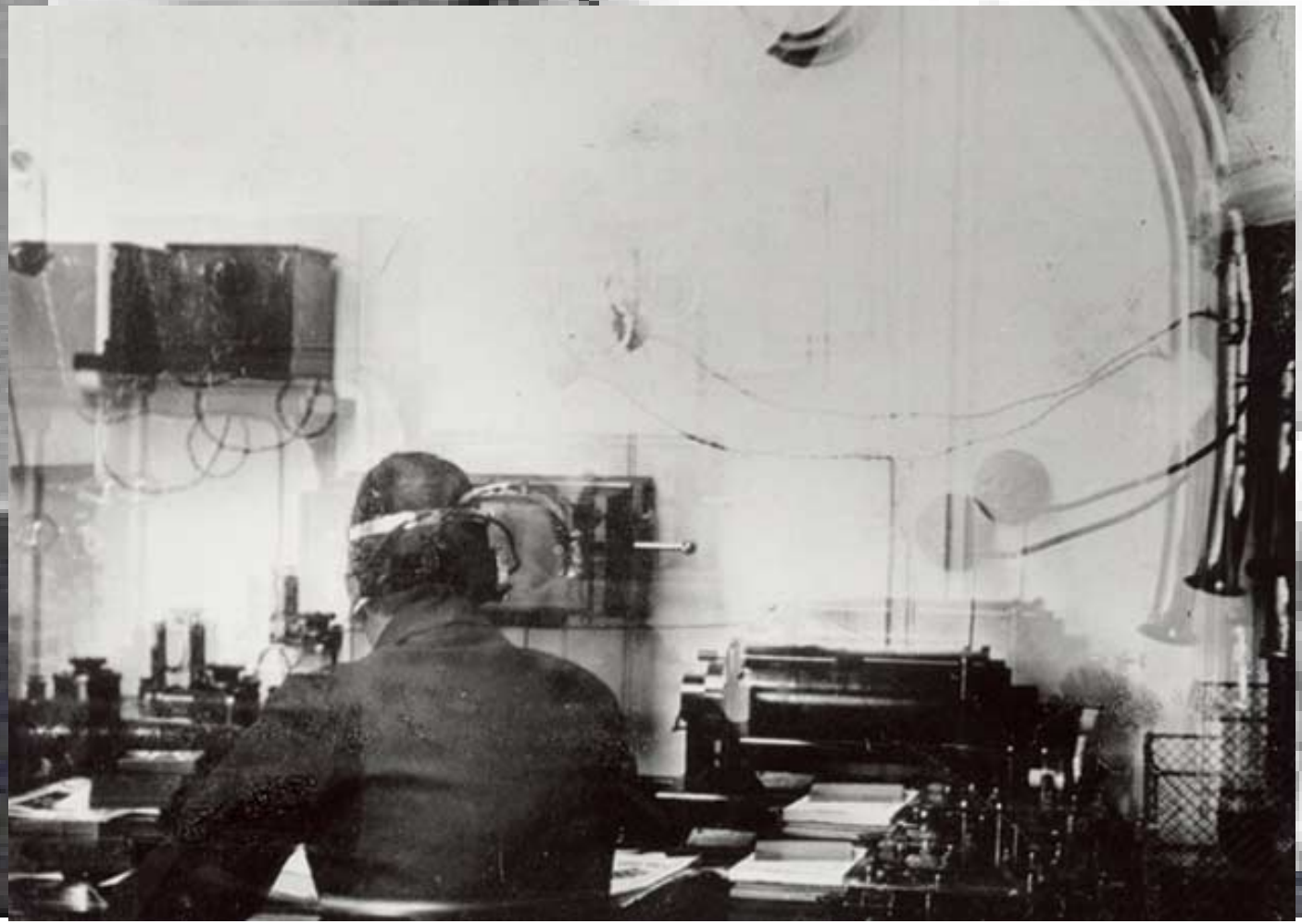
電信所洪萬鑄

Wireless Communication ?



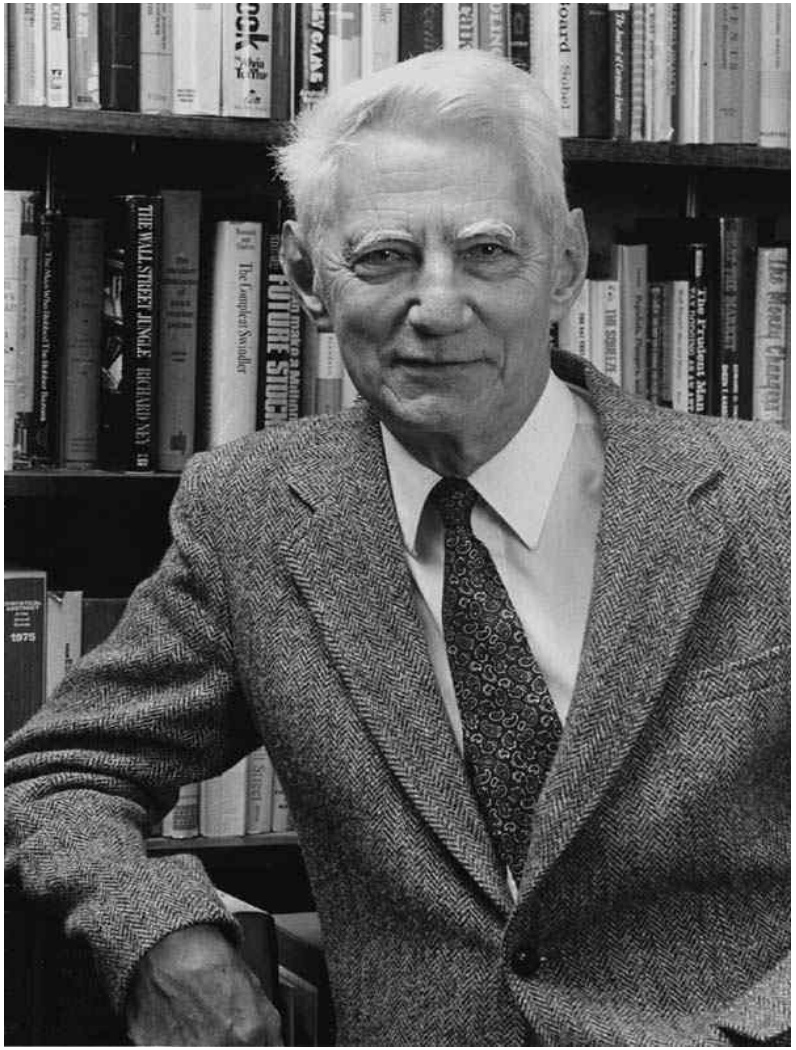
SMOKE SIGNALS

The Titanic



First Mobile Radio Telephone 1924

Claude Elwood Shannon



Claude Elwood Shannon

(1916 - 2001)

Father of Information Theory

Electrical engineer, mathematician, and native son of Gaylord. His creation of information theory, the mathematical theory of communication, in the 1940s and 1950s inspired the revolutionary advances in digital communications and information storage that have shaped the modern world.

This statue was donated by the Information Theory Society of the Institute of Electrical and Electronics Engineers, whose members follow gratefully in his footsteps.

Dedicated October 6, 2000
Eugene Daub, Sculptor

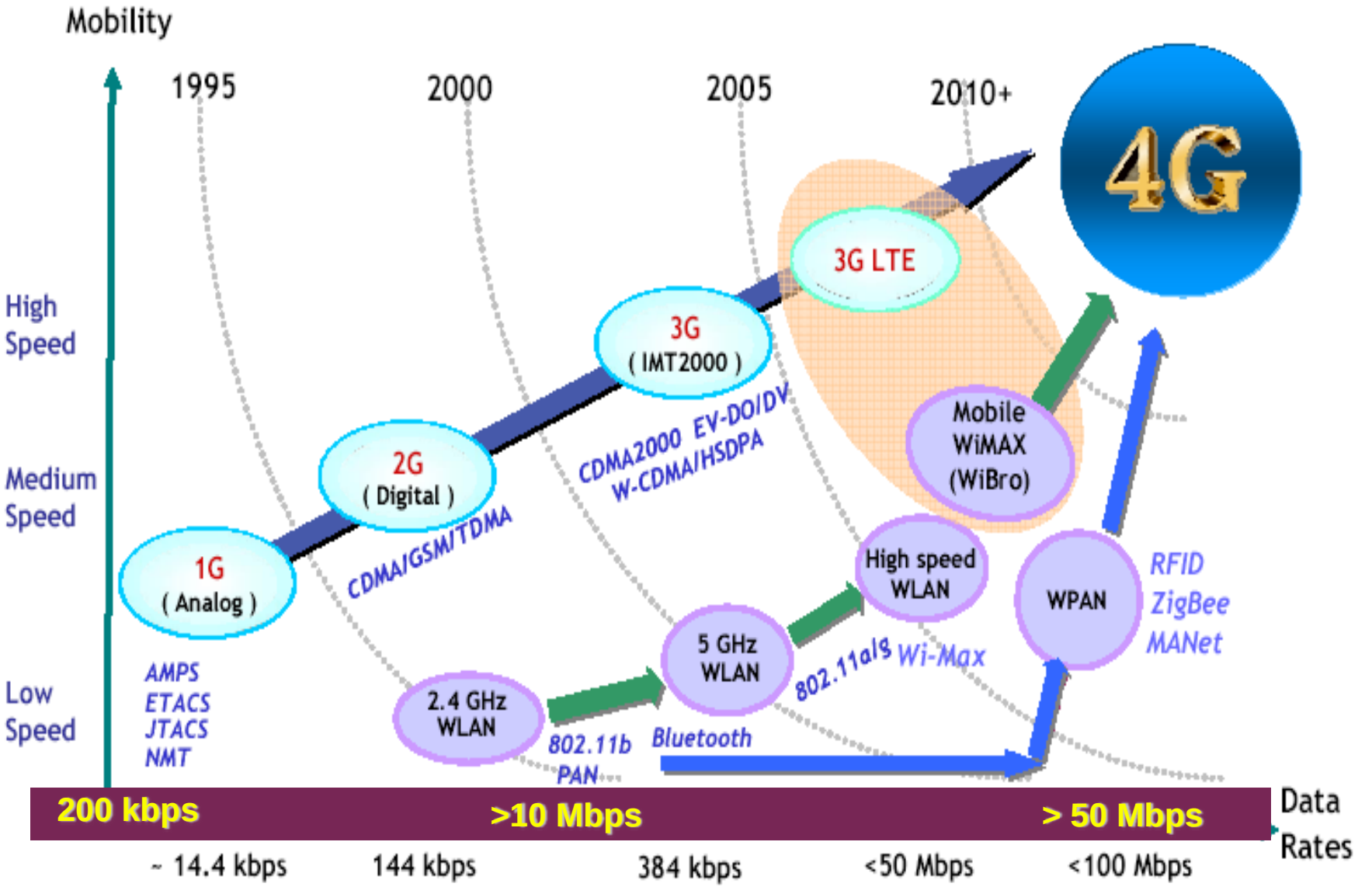
Apple Smartphone iPhone 4

第四代iPhone的供應鏈

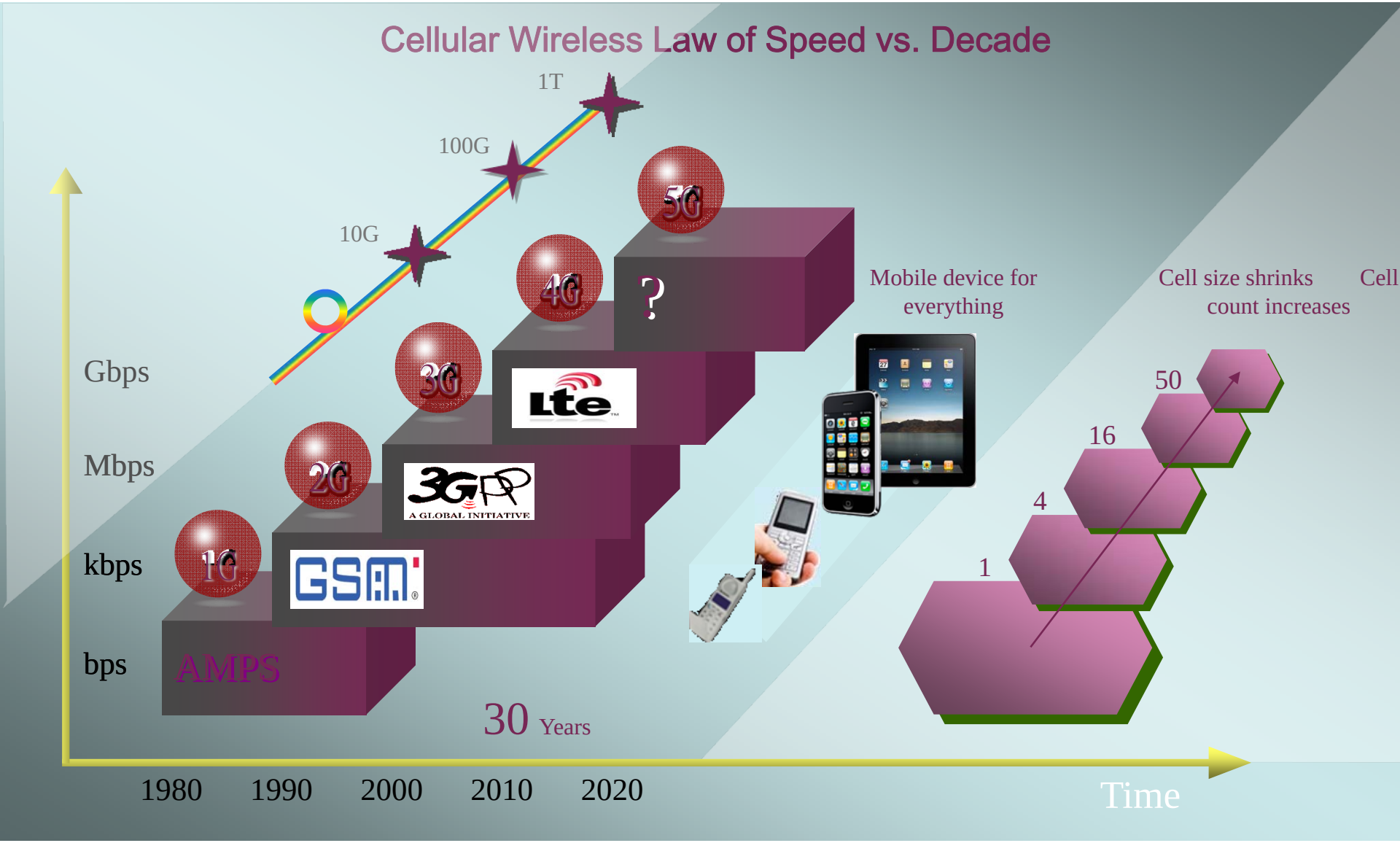
產品項目	廠商	占比(%)	與之前供貨比較
組裝	鴻海	100	未變動
觸控面板模組	宸鴻、勝華、新奇美	45、40、15	新增新奇美(原群創)
石英元件	晶技	45	原本15%，提高到45%
IC載板	景碩	100	未變動
鏡頭模組	大立光、玉晶光	80、20	新增玉晶光(僅視訊鏡頭，非500萬畫素鏡頭)
軟性銅箔基板	台虹	65	原本20%，提高到65%
檢測X-Ray機台	德律	100	未變動

資料來源：各公司　　印證儀／製表

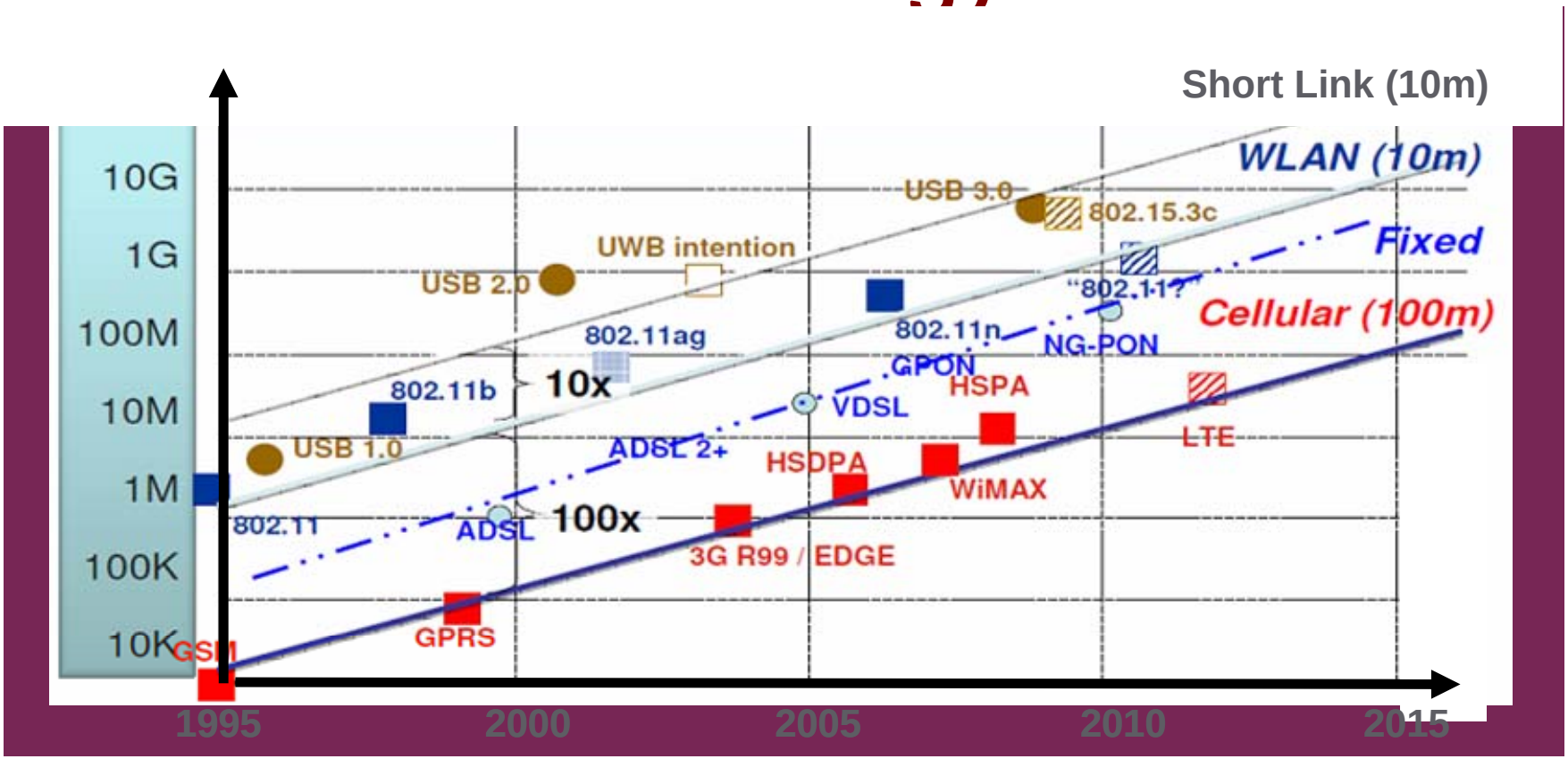
All Roads Lead to 4G (Eventually)



Mobile Broadband Landscape



The Real World Access Technology



- ☑ **Same trend for WLAN, Wireline and Cellular**
- ☑ **Cellular is 10 years behind from WLAN**
- ☑ **1G wireless for WLAN→Gigabit Wireless for cellular in 2020**

The Rise of Mobile Broadband

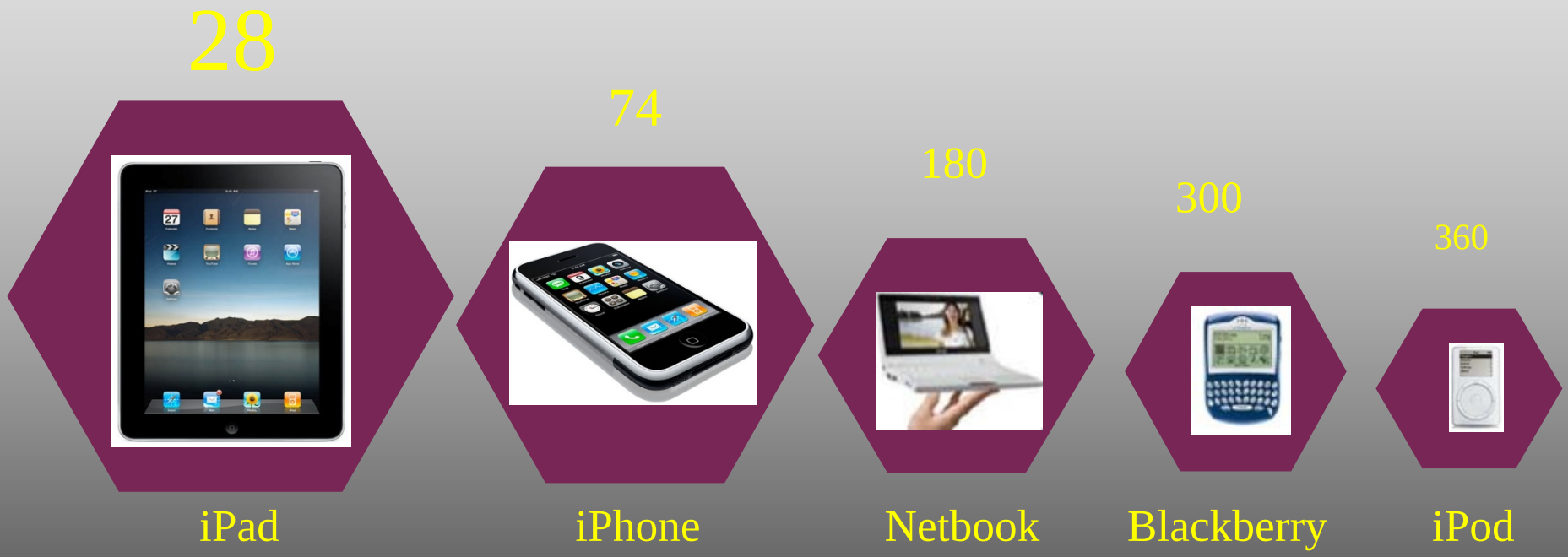
To enable x10 (speed) x10 (devices) x10 (industries)

Connected Devices

Anything that *can* be connected will be connected

Massive User Expectation Change

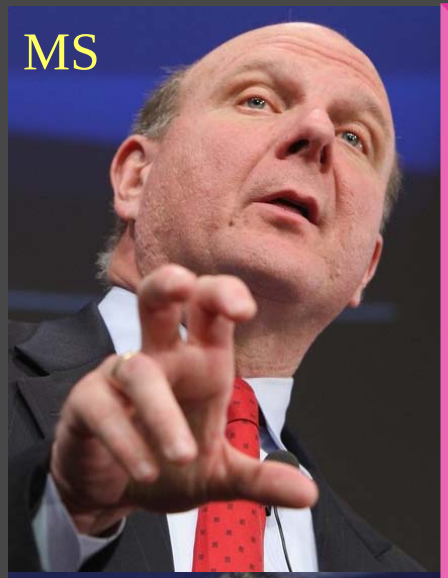
Number of Days to Reach 1 Million Units Sold

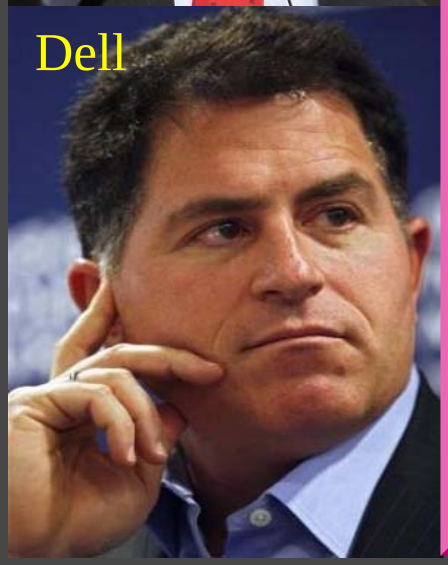


- Always-On Access with Super-Fast *Boot Time*
- *Near Zero Latency* Access to All Information
- *Day-Long-Plus* Battery Life in Elegant Portable Devices

The New Era of Cloud Computing

Empowered by Virtualization and Mobile Broadband Device



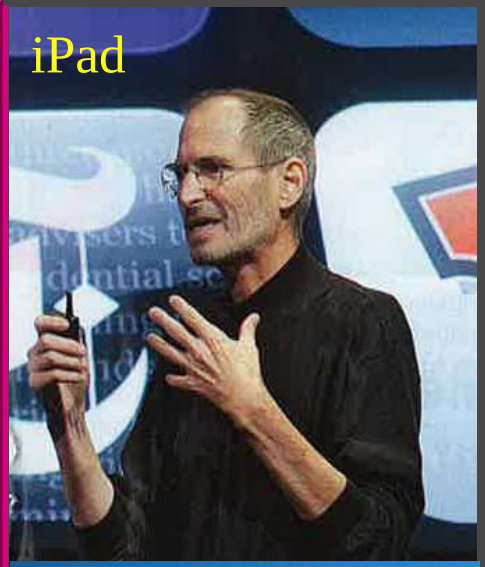


The Grand Transformation

Desktop → Notebook → Netbook

- ☑ In 5 years, 25% of computing devices will be wireless tablet or netbook.
- ☑ Today, desktop has 5% growth, notebook 17% (down from 25%).
- ☑ Windows has 5% market share in mobile device, Android approaching 20%.

In 2020, people will not work with software running on their PC, rather via the Internet and cloud-based applications with mobile devices



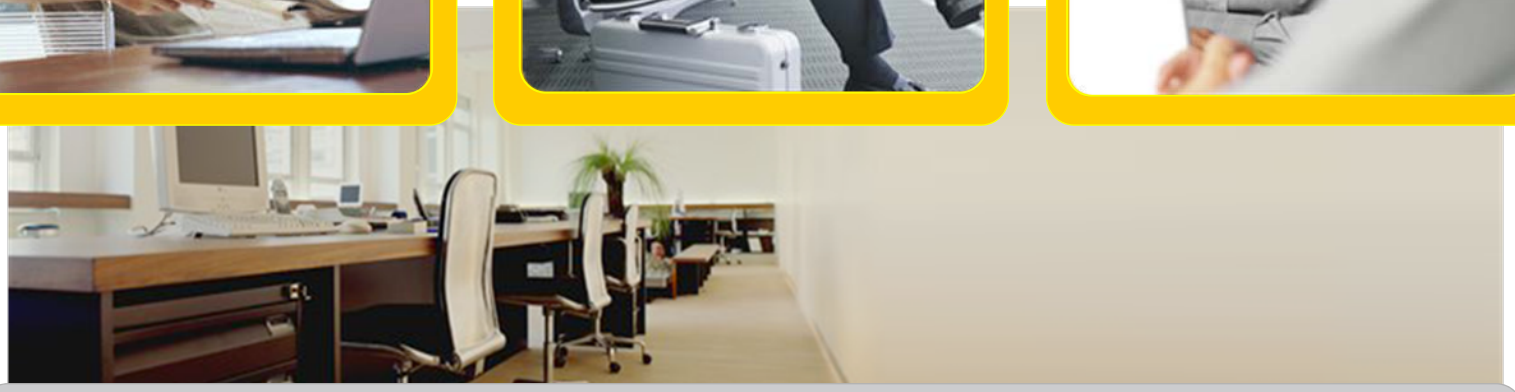
Market Trends

Tire Down the Walls, Make World Your Office

At Home

On the Go

At Work



Next Generation Wireless → Affordable Personal Mobility Multimedia Service

Key Technical Challenges

Affordable
1Mbps
anytime, anywhere

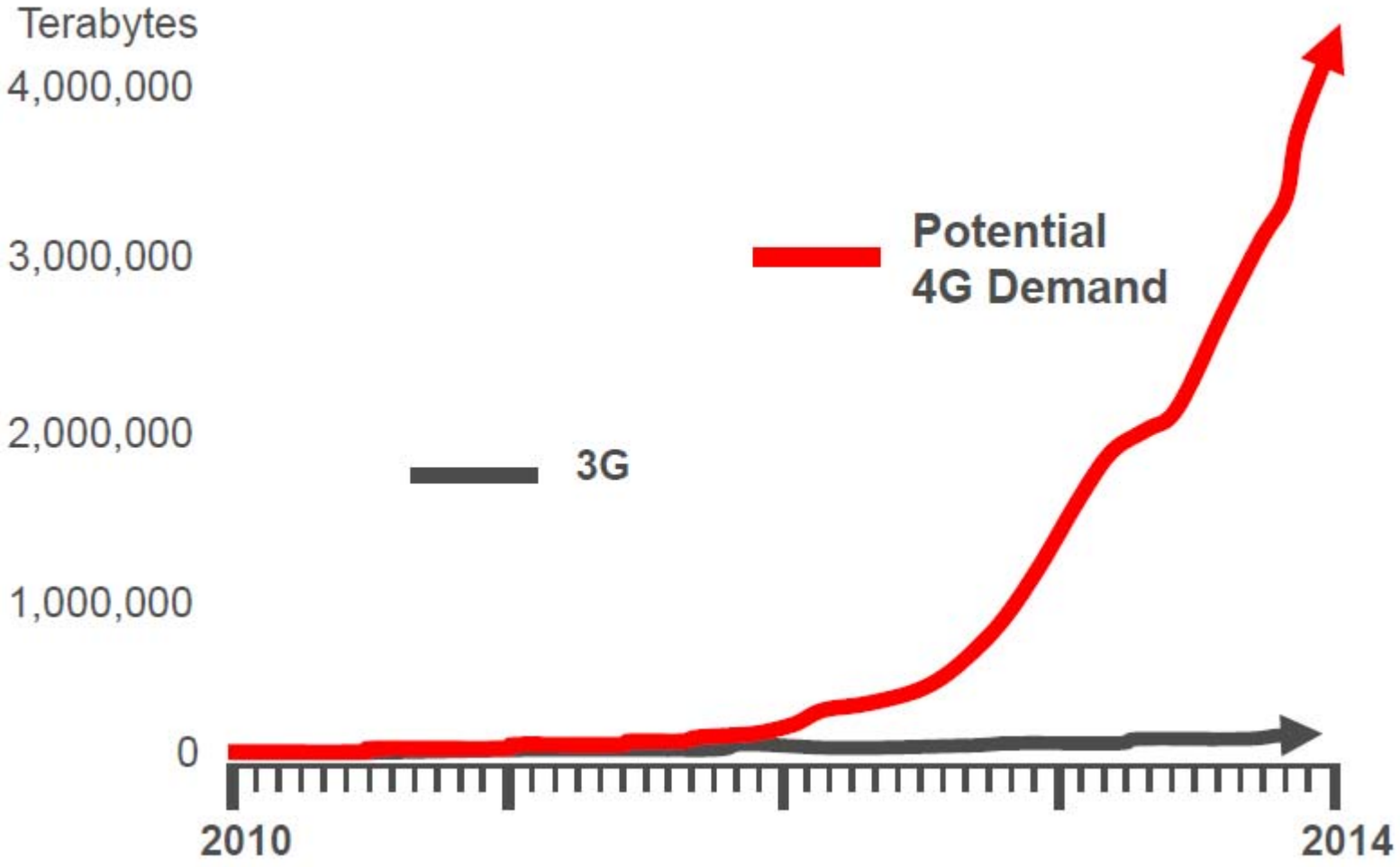
Low Latency <20ms

Full Mobility 350km/h

Seamless Coverage

High Data Rate

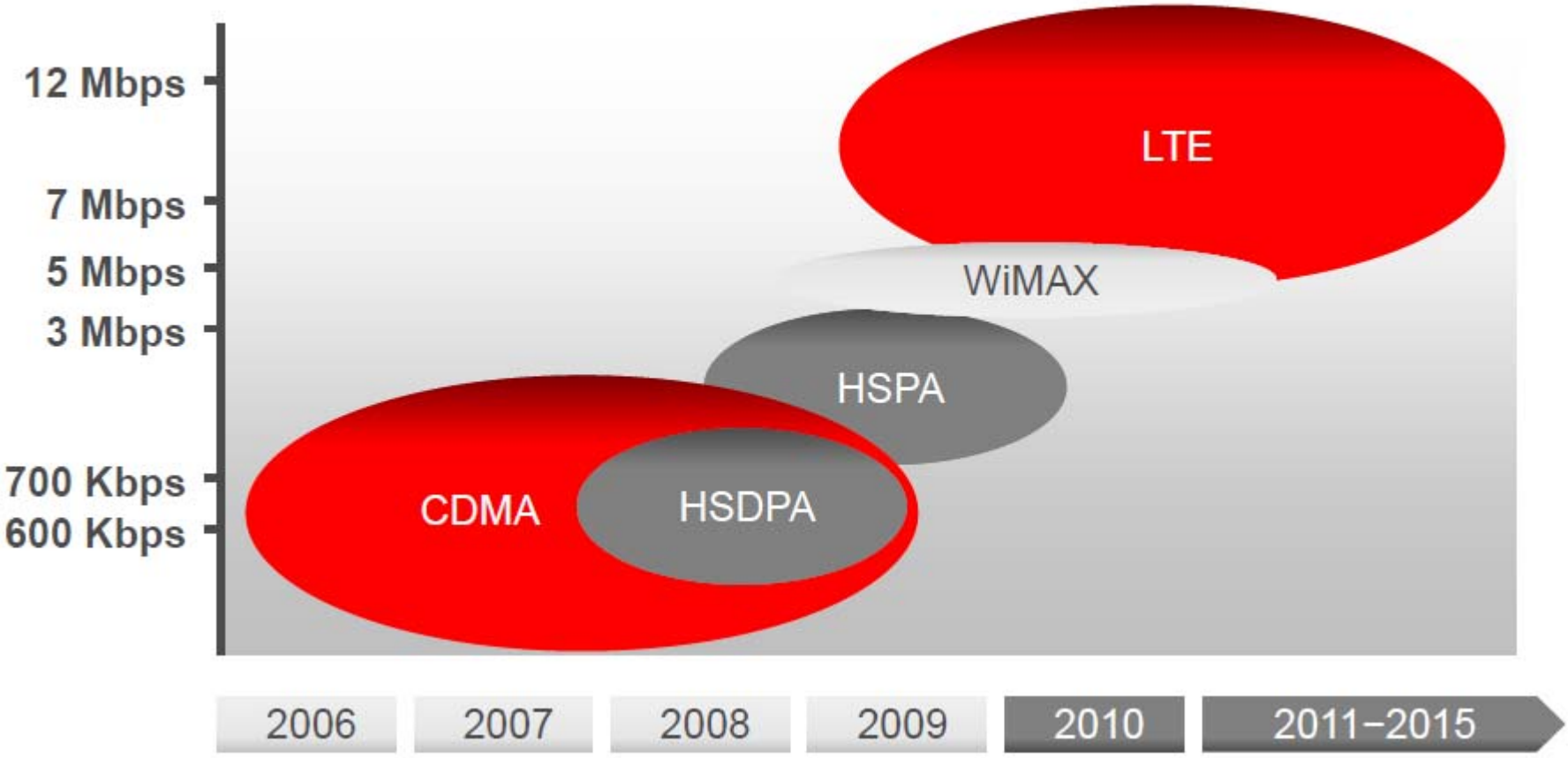
Wireless Data Trends



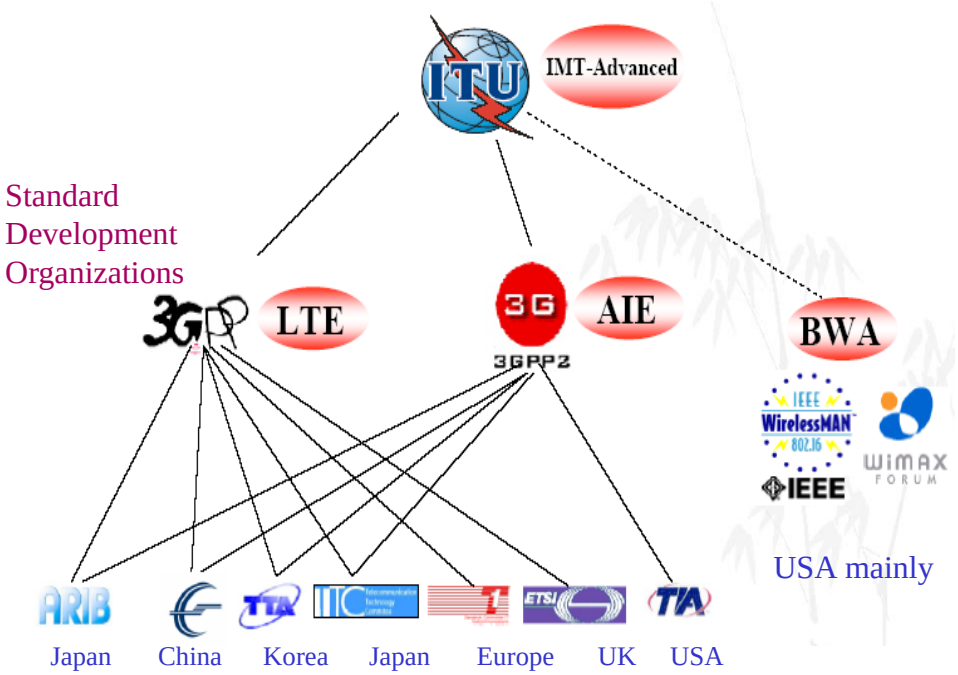
Beyond 3G

- Evolutionary path beyond 3G
  - Mobile class targets 100 Mbps with high mobility
  - Local area class targets 1 Gbps with low mobility
- 3GPP is currently developing evolutionary/ revolutionary systems beyond 3G
  - 3GPP Long Term Evolution (LTE)
- IEEE 802.16-based WiMAX is also evolving towards 4G through 802.16m

Wireless Data Trends



What is 4G? ITU-Rs' Perspective



- **A high degree of commonality of functionality worldwide while retaining the flexibility to support a wide rage of services and applications.**
- **Capability of inter-working with other radio access systems.**
- **Capability of services within IMT and with fixed networks.**
- **Enhanced peak data rates 100Mbps for high mobility and 1Gbps for low mobility**

What is LTE ?

- In Nov. 2004, 3GPP began a project to define the long-term evolution (LTE) of Universal Mobile Telecommunications System (UMTS) cellular technology
  - **Higher performance**
  - **Backwards compatible**
  - **Wide application**

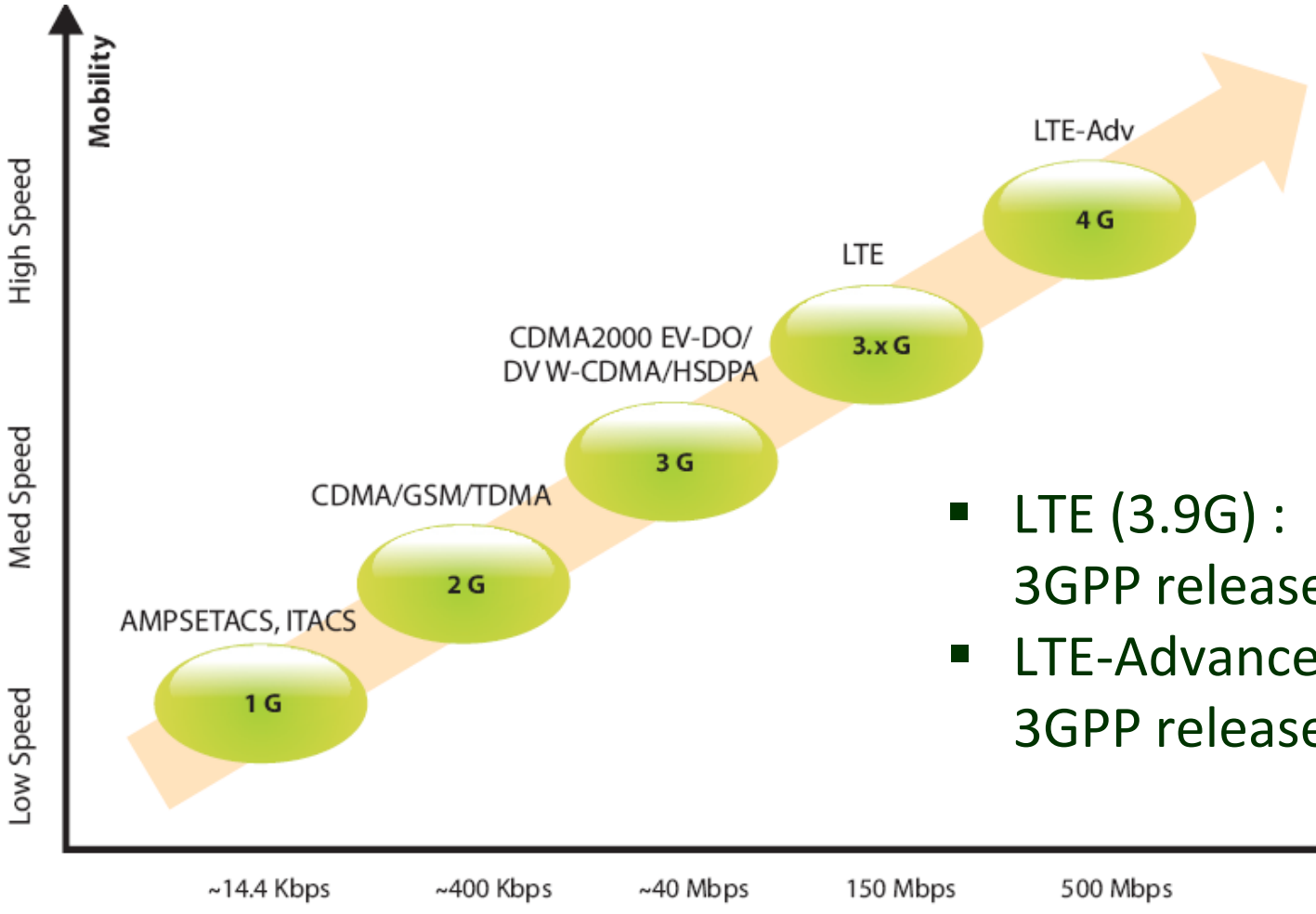
Requirements for LTE

- Peak data rate
  - 100 Mbps DL/ 50 Mbps UL within 20 MHz bandwidth.
  - Up to 200 active users in a cell (5 MHz)
  - Less than 5 ms user-plane latency
- Mobility
  - Optimized for 0 ~ 15 km/h.
  - 15 ~ 120 km/h supported with high performance.
  - Supported up to 350 km/h or even up to 500 km/h.
- Spectrum flexibility: 1.25 ~ 20 MHz
- Enhanced support for end-to-end QoS

Long Term Evolution(LTE)-Advanced: Key Features

- Compatibility of services
- Enhanced peak data rates to support advanced services and applications (100 Mbit/s for high and 1 Gbit/s for low mobility).
- Spectrum efficiency: 3 times greater than LTE.
- Peak spectrum efficiency: downlink – 30 bps/Hz; uplink – 6.75 bps/Hz.
- Spectrum use: the ability to support scalable bandwidth use and spectrum aggregation where non-contiguous spectrum needs to be used.

Evolution of Radio Access Technologies



- LTE (3.9G) : 3GPP release 8~9
- LTE-Advanced : 3GPP release 10+

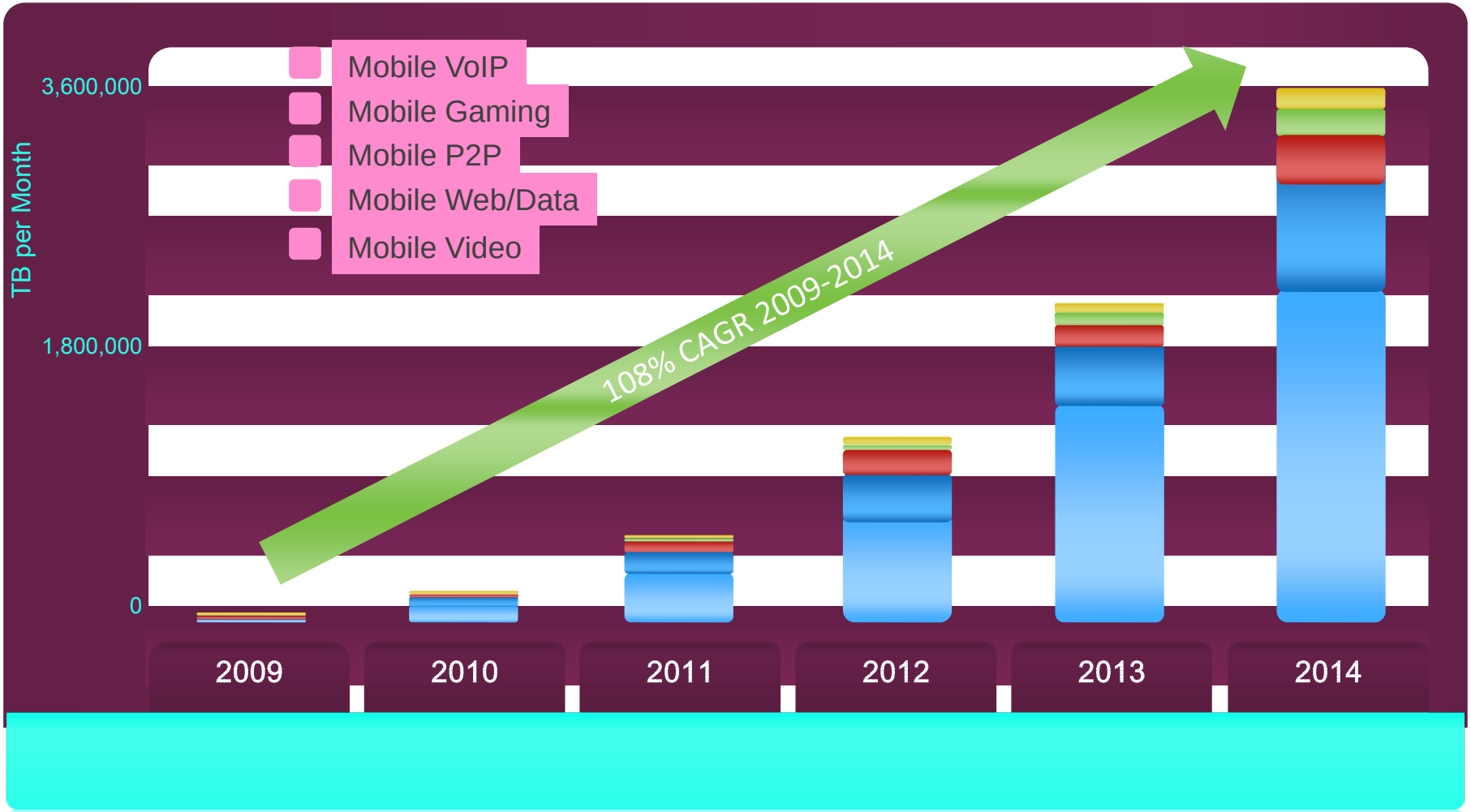
22 Billion Internet-Connected Things

The number of devices connected to the Internet is expected to hit 5 billion this month, says IMS Research, and will reach 22 billion by 2020.

Killer 4G Application: Cloud Computing Goes Mobile

- All their stuff in the palm of their hands 24x7.
- Open ecosystem of applications, content and devices.
- User generated content.
- Business content.
- Demands true broadband connectivity.

Mobile Growth by Traffic Type

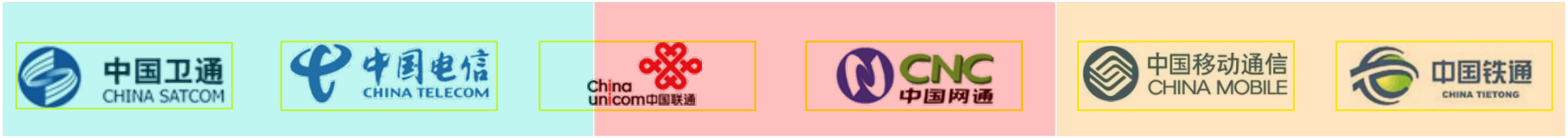


Source: Cisco VNI Mobile, 2010

Smartphones will outship the global notebook + netbook market in 2010 and the global PC market (desktop + notebook + netbook) in 2012.

Morgan Stanley Mobile Internet Report

配合趨勢電信業者版圖整合 範例: China



中国电信 CHINA TELECOM	
Wireless	43.81 M
Phone	196.17 M
Internet	50.56 M
2G: CDMA	
3G: CDMA2000	
4G: LTE	

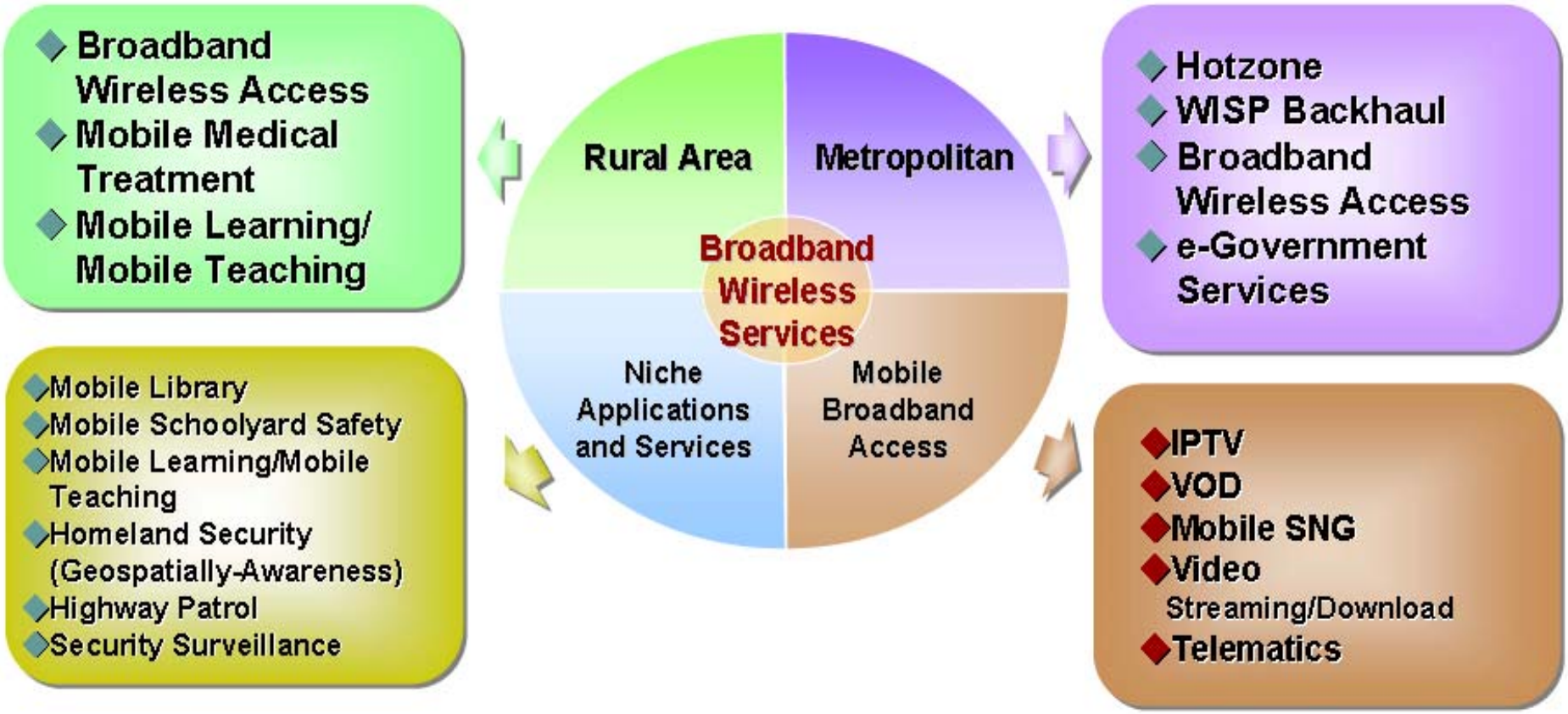
China unicom中国联通	
Wireless	142 M
Phone	107.6 M
Internet	36.6 M
2G: GSM	
3G: WCDMA	
4G: LTE	

中国移动通信 CHINA MOBILE	
Wireless	502.9M
Phone	in millions*
Internet	in millions*
2G: GSM	
3G: TDS-CDMA	
4G: LTE	

* Till Aug 2009

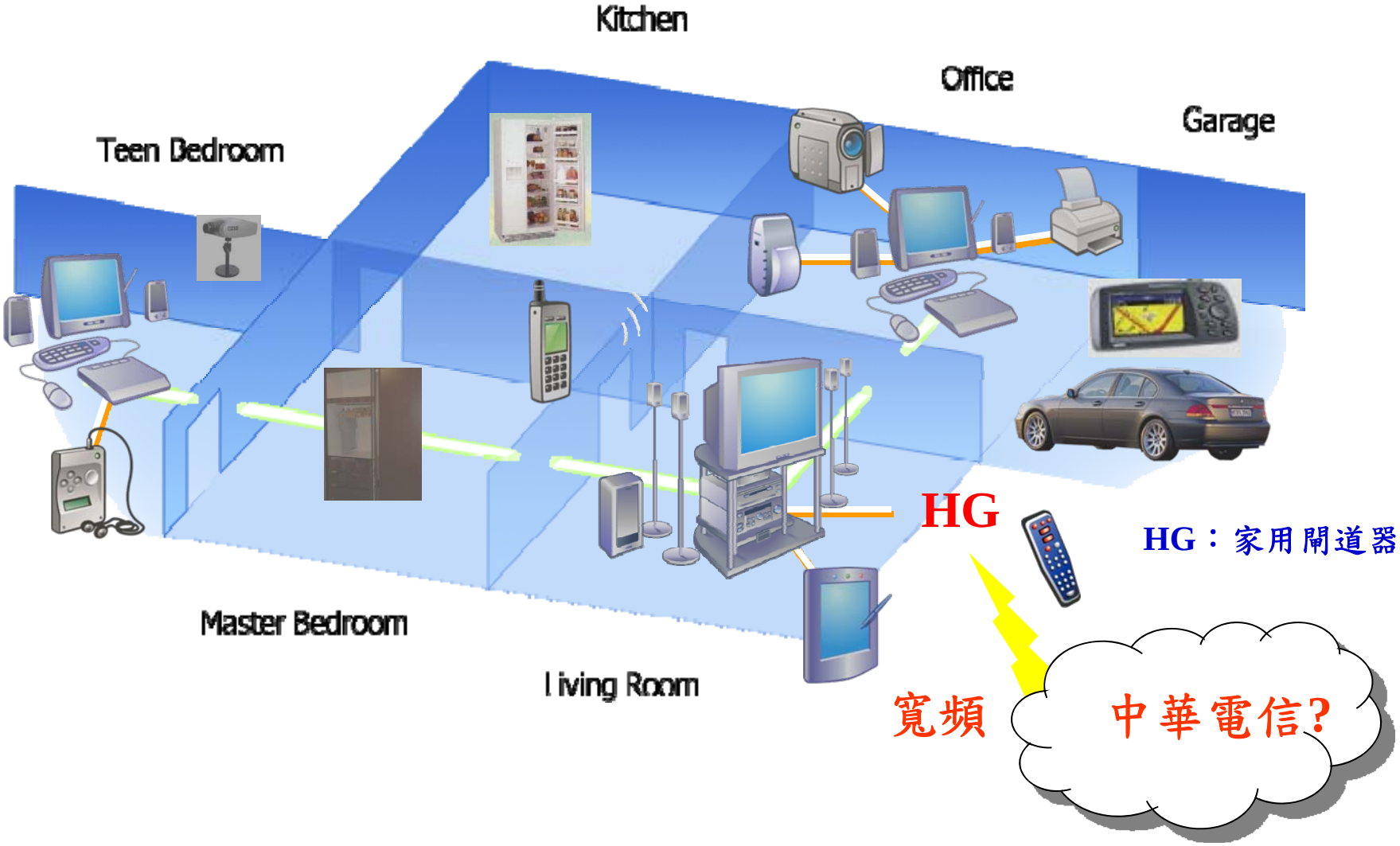
資料摘至：中華電信研究所，2009年11月

寬頻無線上網服務應用



資料摘至：中華電信研究所，2009年11月

未來的戰場：家庭網路


Kitchen
Office
Garage
Teen Bedroom
Master Bedroom
Living Room
HG
HG：家用閘道器
寬頻
中華電信?

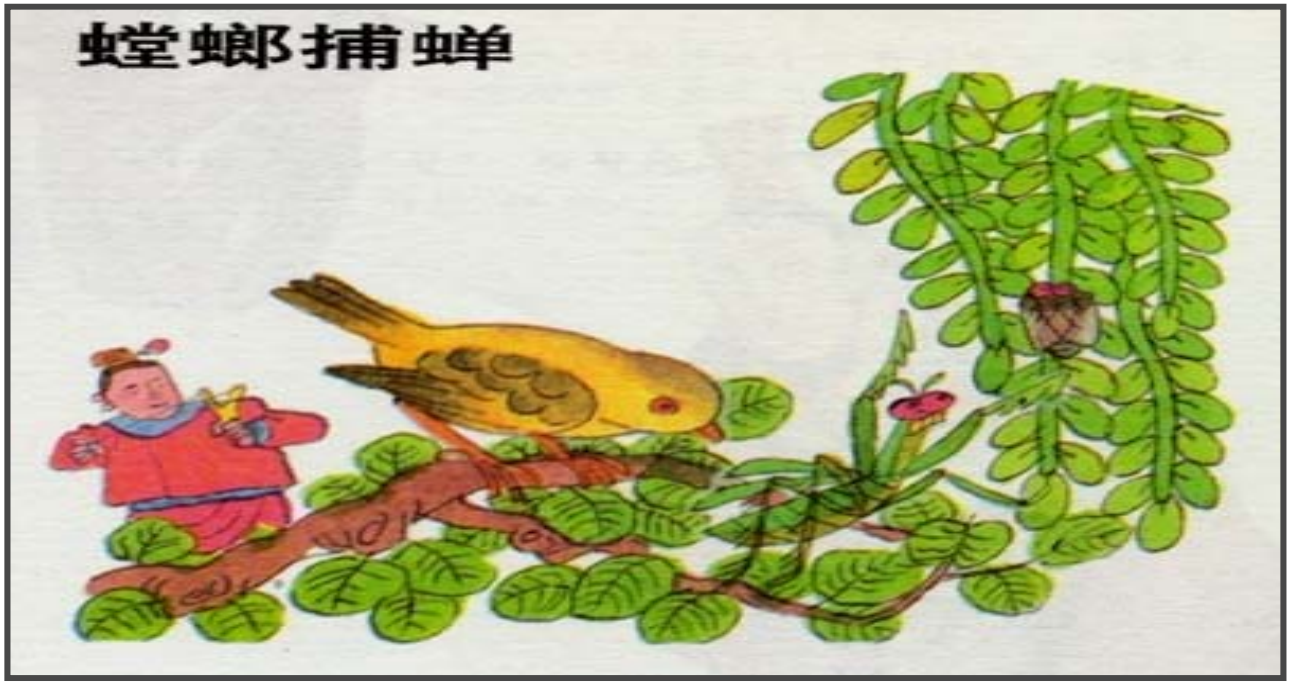
Wireless Health

The wireless future of medicine

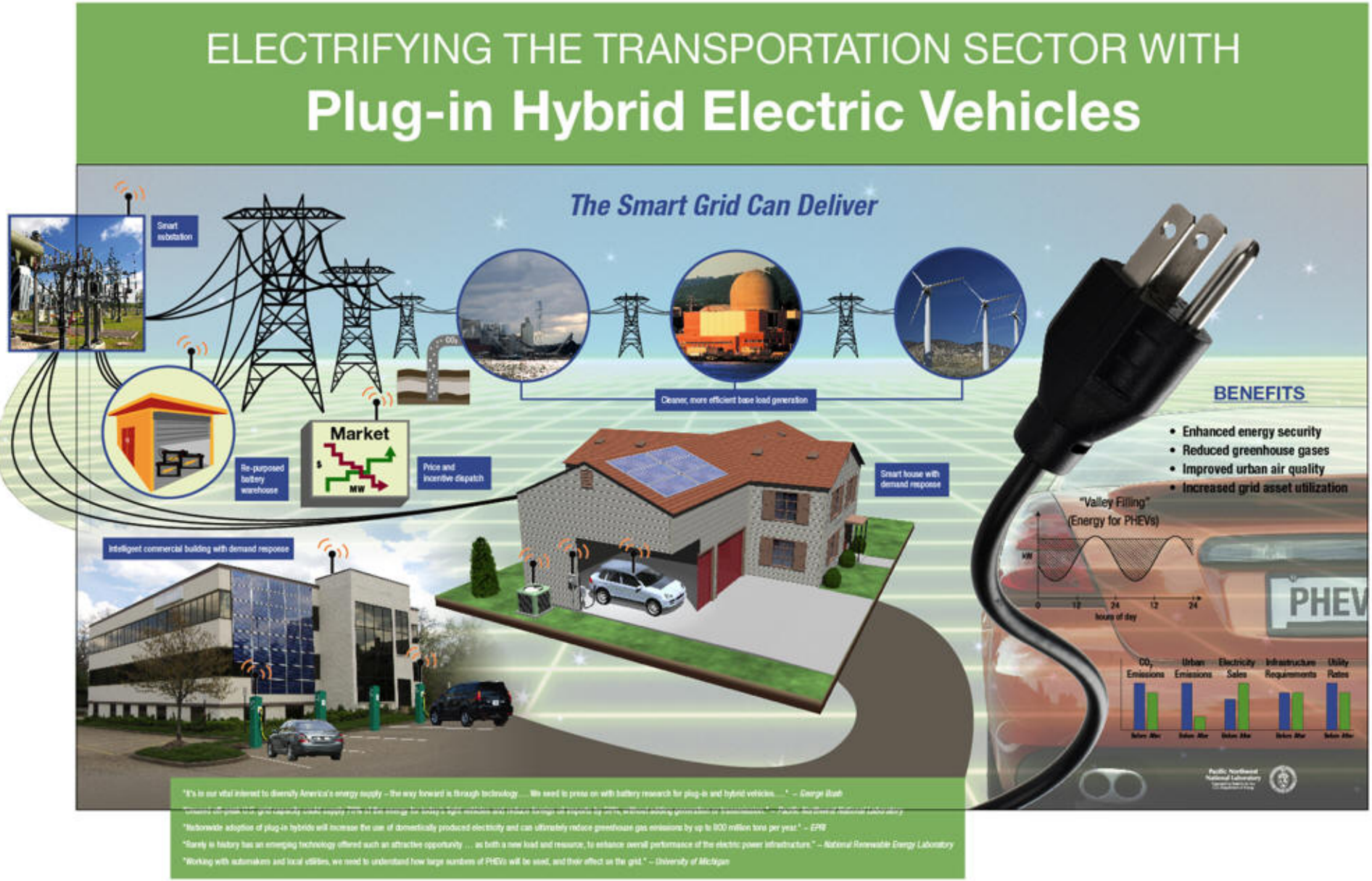
Qualcomm

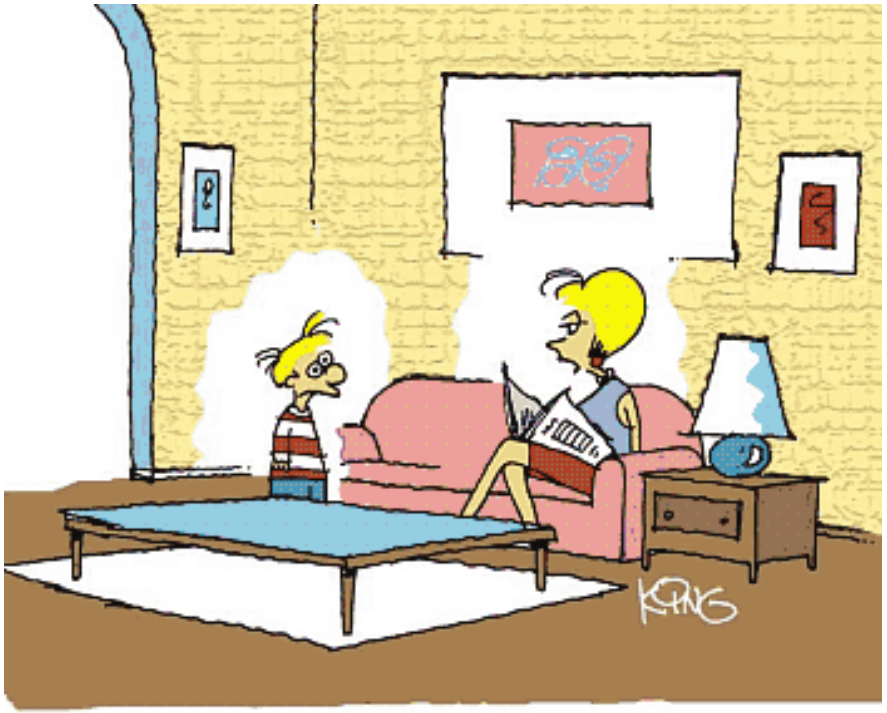
Interplay among Alternative Technologies

- The Game
- The hunter has the power to decide who wins



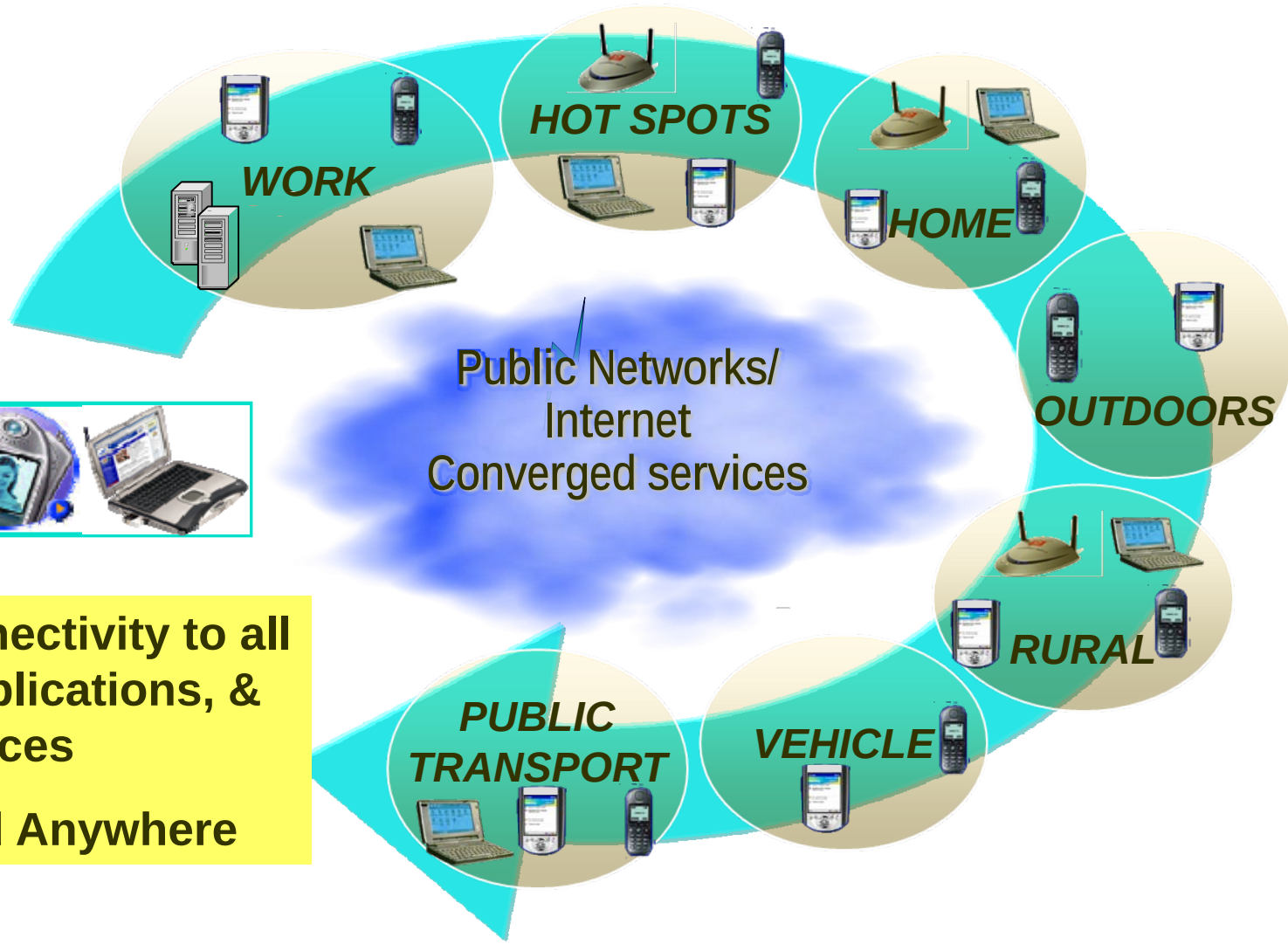
From Dr. C.K. Mao: Telecom Regulation (APEC Workshop)


ELECTRIFYING THE TRANSPORTATION SECTOR WITH
Plug-in Hybrid Electric Vehicles
The Smart Grid Can Deliver
Smart substation
Cleaner, more efficient base load generation
Market
$
MW
Re-purposed battery warehouse
Price and incentive dispatch
Smart house with demand response
Intelligent commercial building with demand response
BENEFITS
Enhanced energy security
Reduced greenhouse gases
Improved urban air quality
Increased grid asset utilization
"Valley Filling"
(Energy for PHEVs)
kW
0
12
24
12
24
hours of day
PHEV
CO_2 Emissions
Urban Emissions
Electricity Sales
Infrastructure Requirements
Utility Rates
Before
After
"It's in our vital interest to diversify America's energy supply – the way forward is through technology.... We need to press on with battery research for plug-in and hybrid vehicles...." – George Bush
"Nationwide adoption of plug-in hybrids will increase the use of domestically produced electricity and can ultimately reduce greenhouse gas emissions by up to 800 million tons per year." – EPRI
"Rarely in history has an emerging technology offered such an attractive opportunity ... as both a new load and resource, to enhance overall performance of the electric power infrastructure." – National Renewable Energy Laboratory
"Working with automakers and local utilities, we need to understand how large numbers of PHEVs will be used, and their effect on the grid." – University of Michigan



"No, you weren't downloaded.
Your were born."

Wireless Future :
A Seamless Mobile Lifestyle



Seamless connectivity to all networks, applications, & services

Anytime and Anywhere

Challenges

- Social (e.g. children's use)
- Political (e.g. posting false info)
- Policy (e.g. access)
- Legal (e.g. copyright)
- Technical (e.g. security)

These fundamental issues are closely intertwined and must be addressed if we are to realize the opportunities before us.

Questions?

Comments?