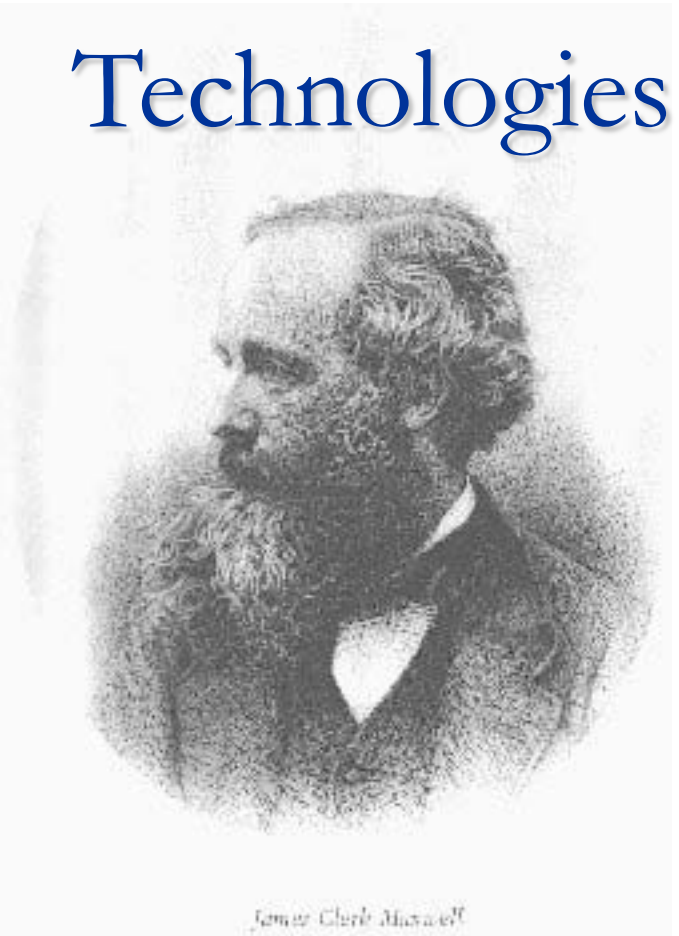


# 工程與生活

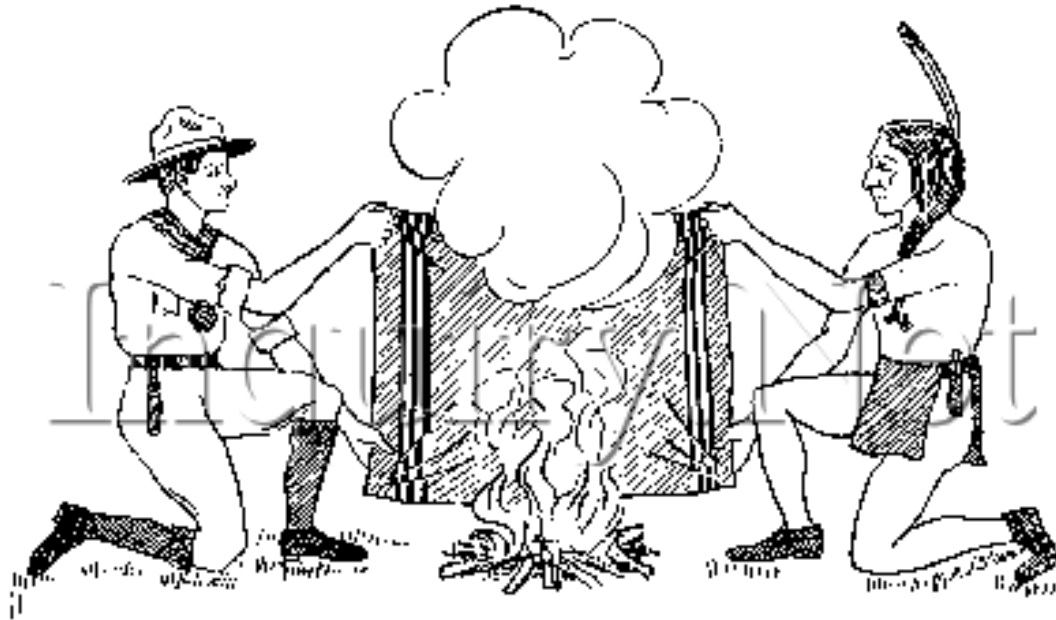
## Wireless Technologies



電信所洪萬鑄

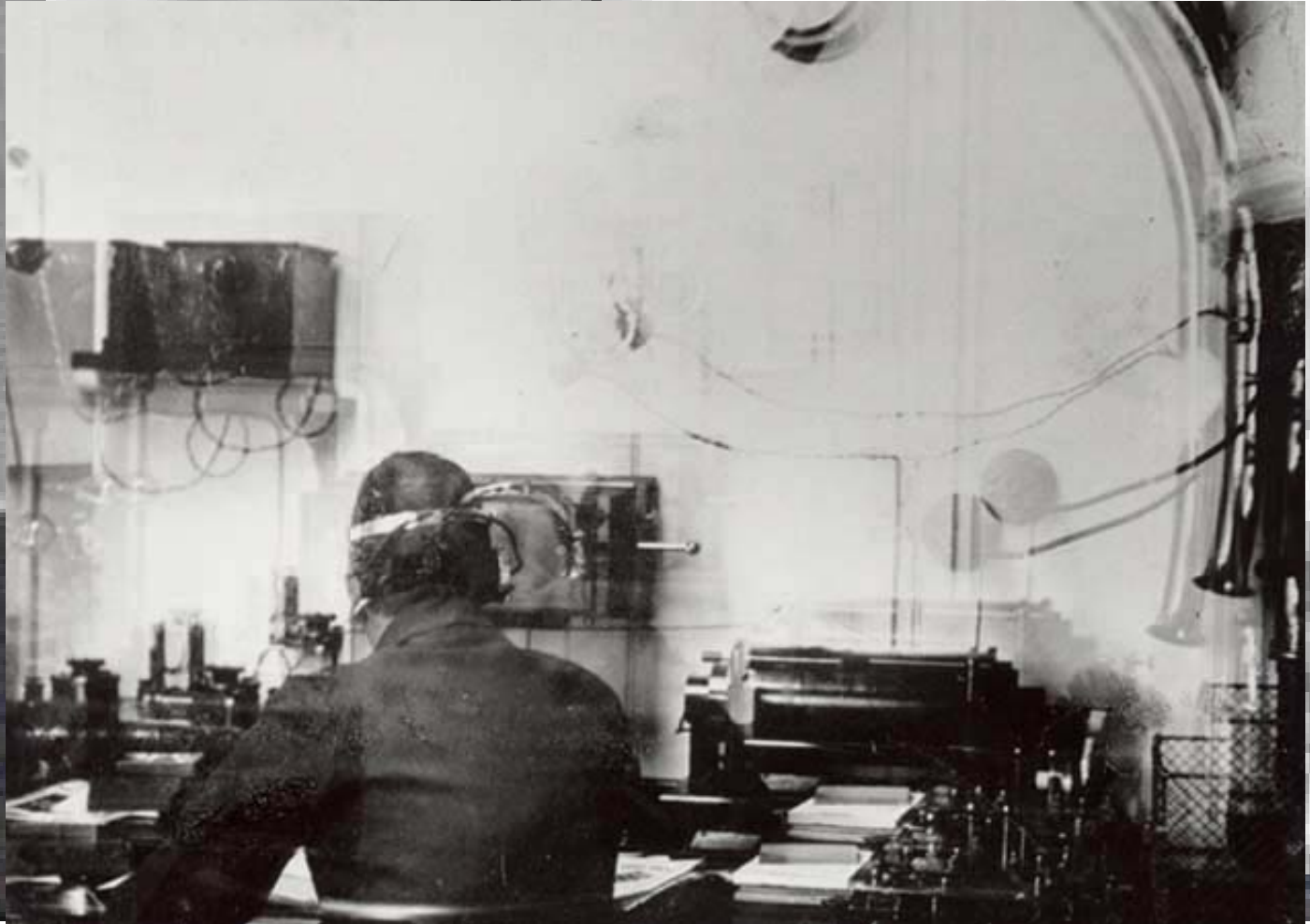
NCUE EE\_dept/GICE

# Wireless Communication ?



SMOKE SIGNALS

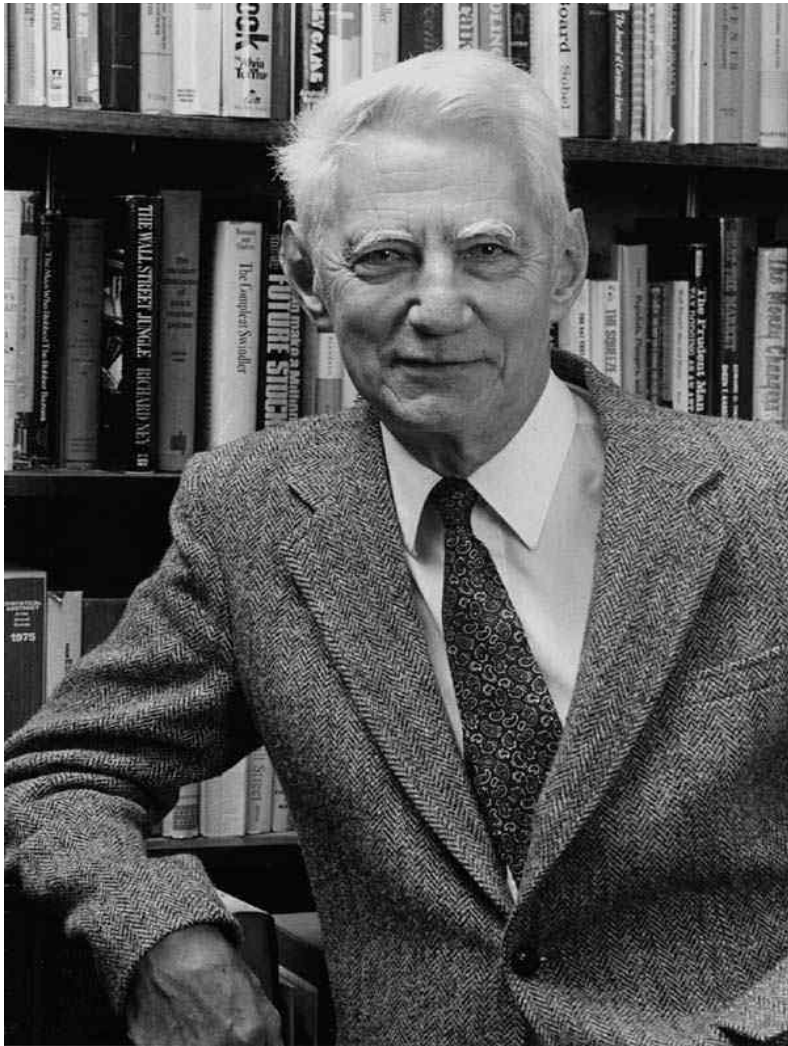
# The Titanic



# 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

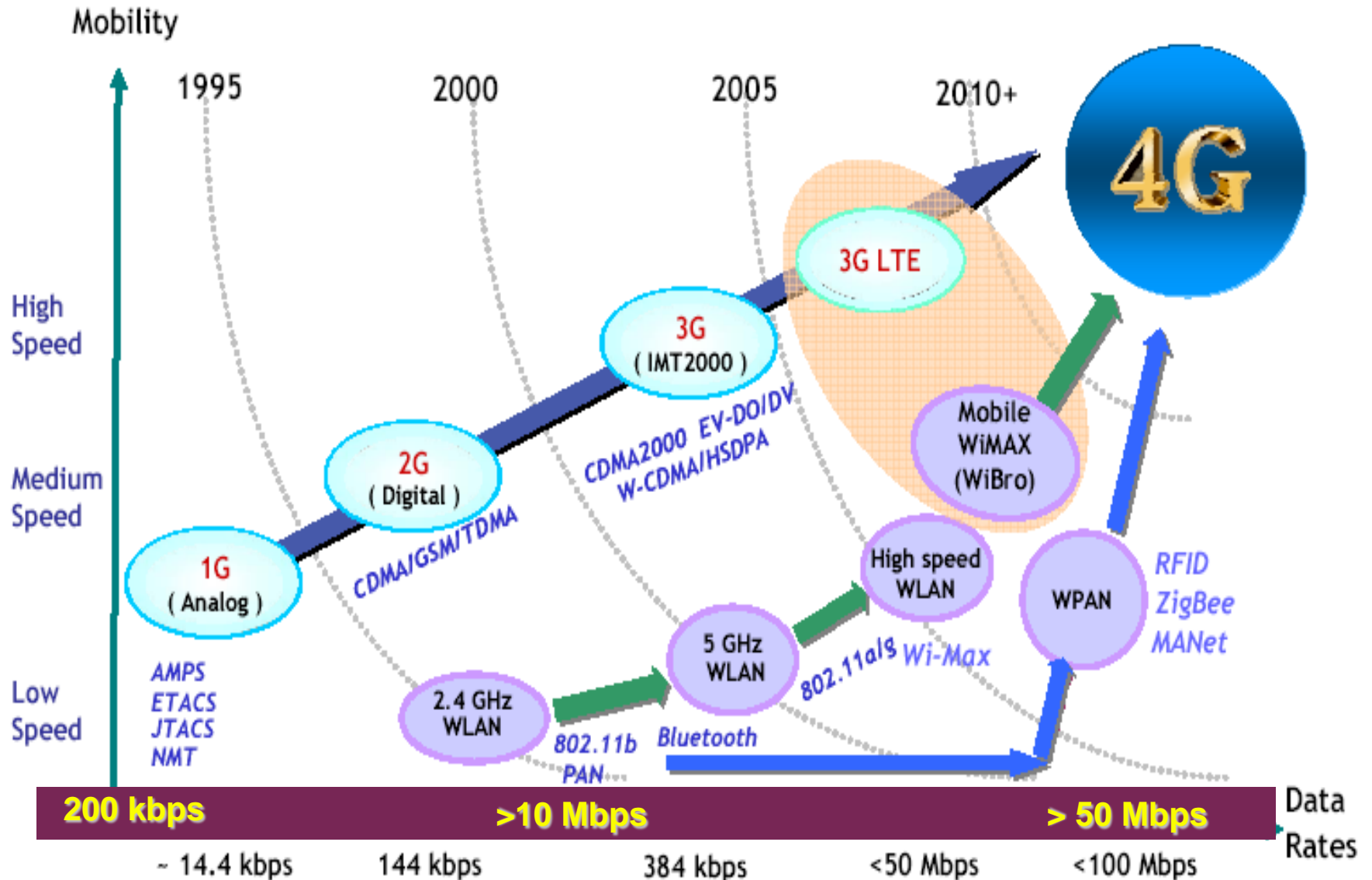


### 第四代iPhone的供應鏈

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晶片	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

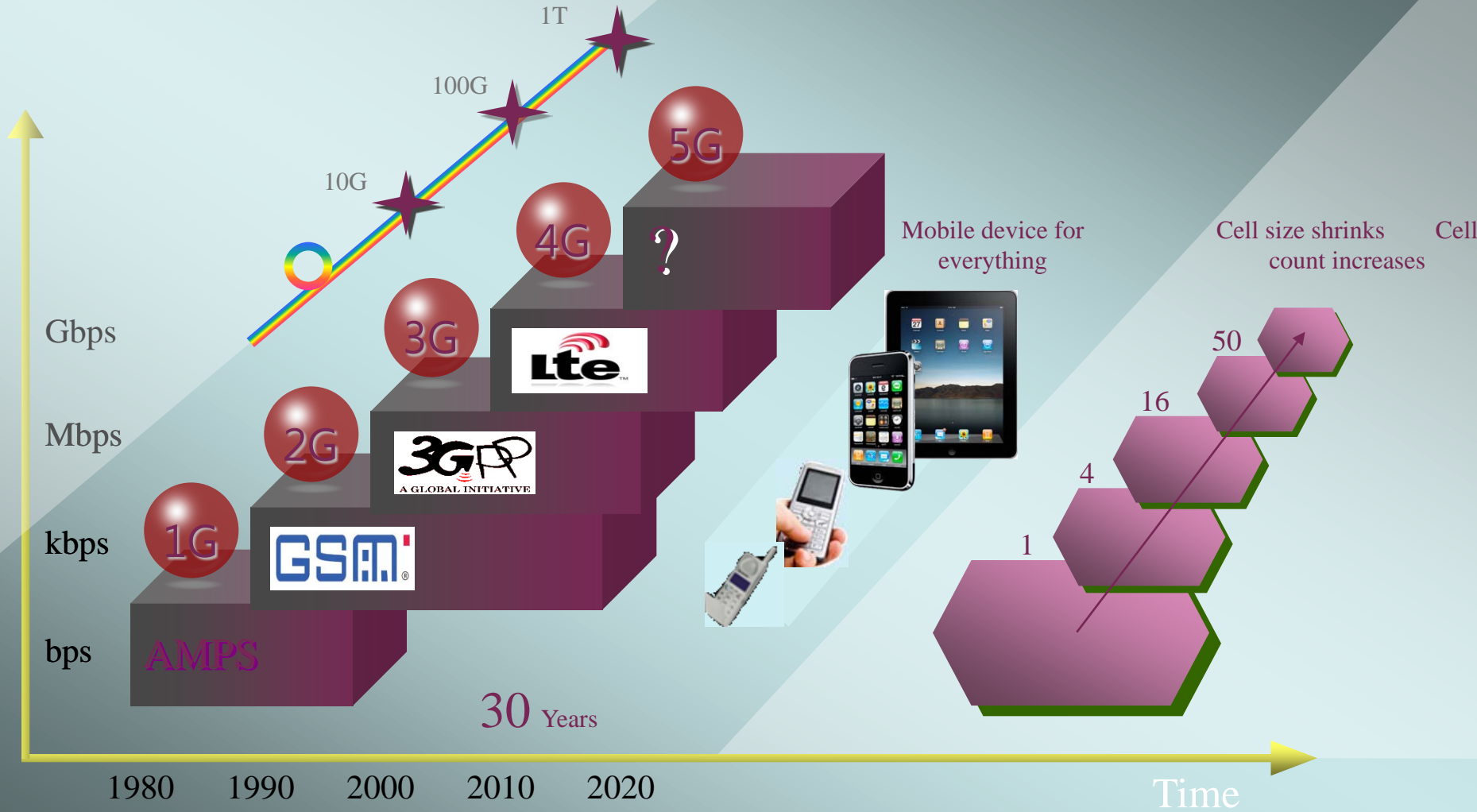
資料來源：各公司  
印營儀/製表

# All Roads Lead to 4G (Eventually)

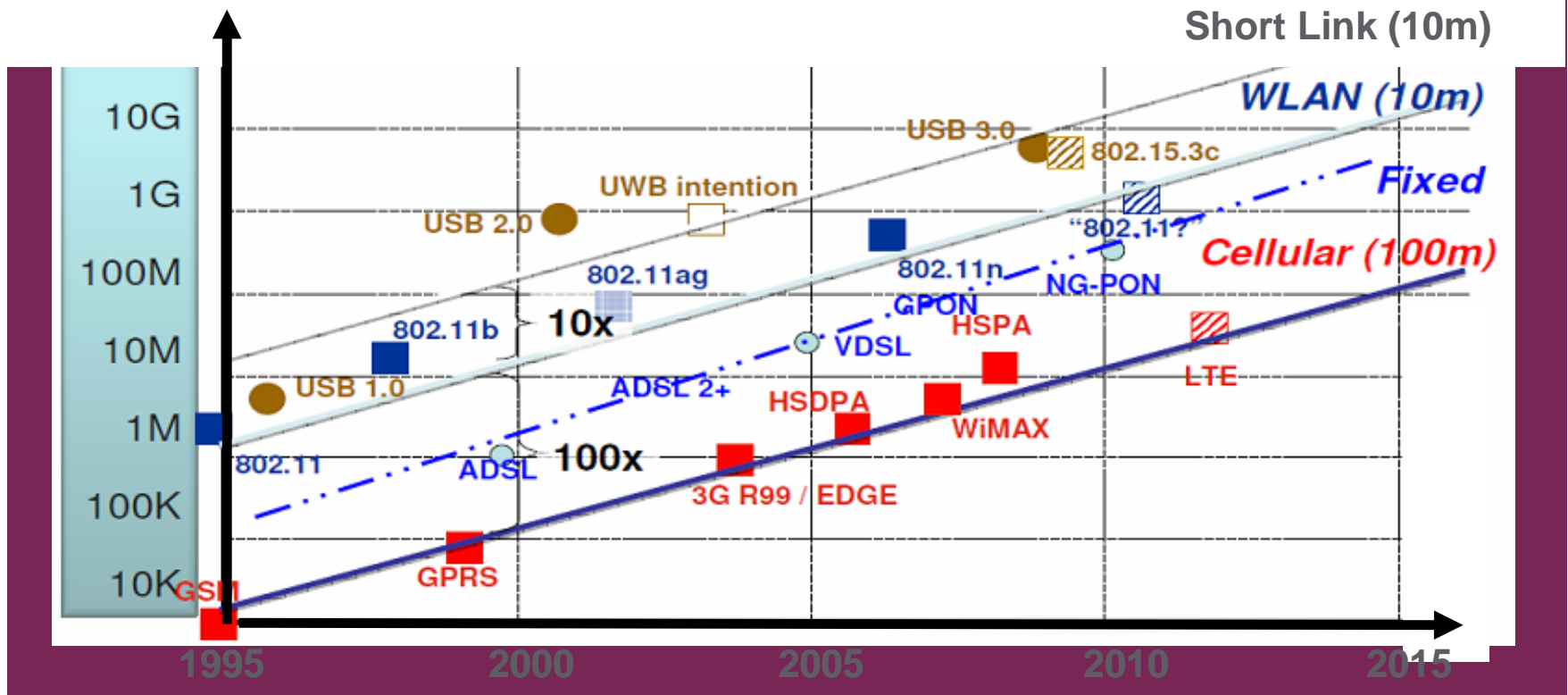


# Mobile Broadband Landscape

Cellular Wireless Law of Speed vs. Decade



# 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

28



iPad

74



iPhone

180



Netbook

300



Blackberry

360



iPod

- *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

MS

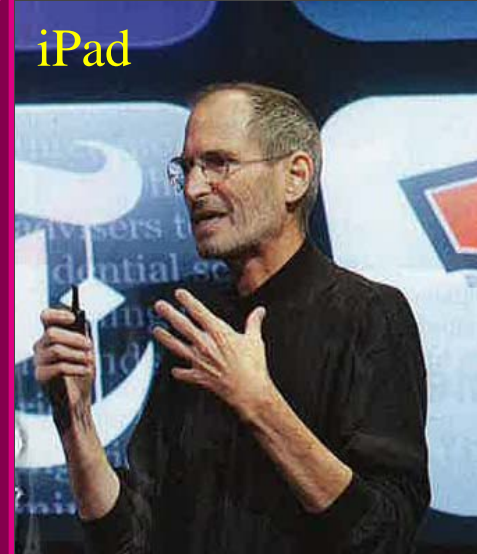


The Grand Transformation  
Desktop → Notebook → Netbook

- ✓ 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

iPad



Android



# 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



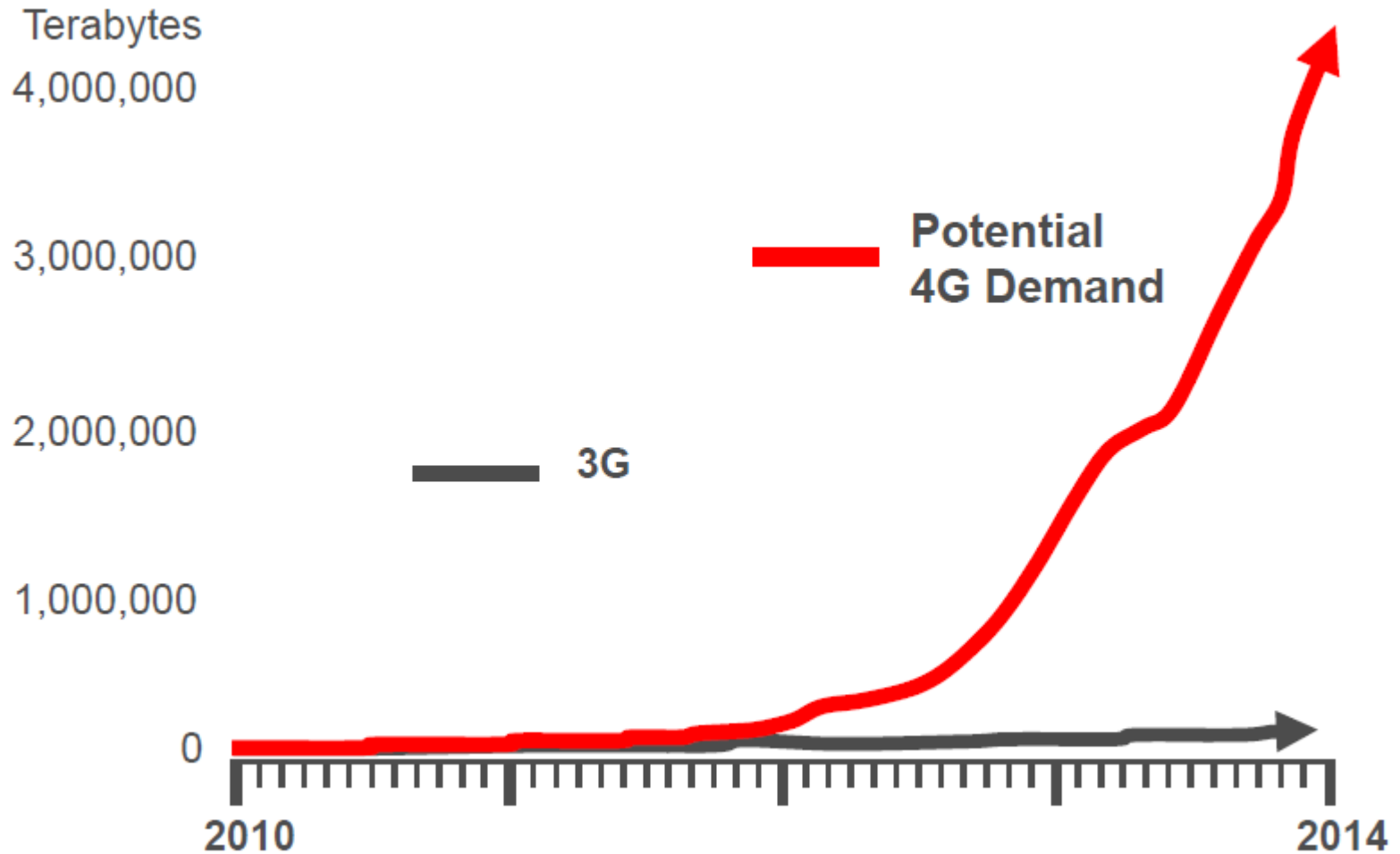
Seamless Coverage



High Data Rate



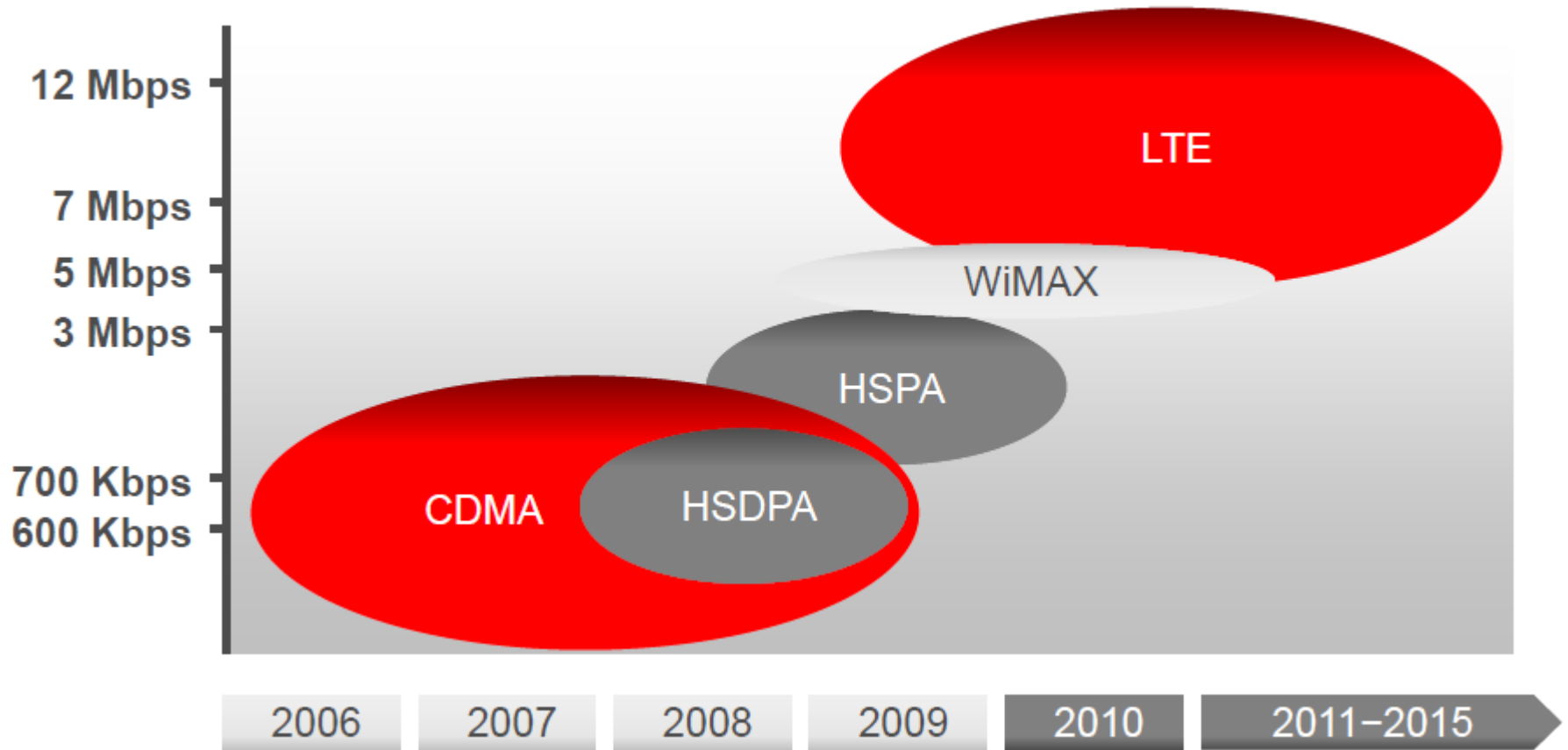
# Wireless Data Trends



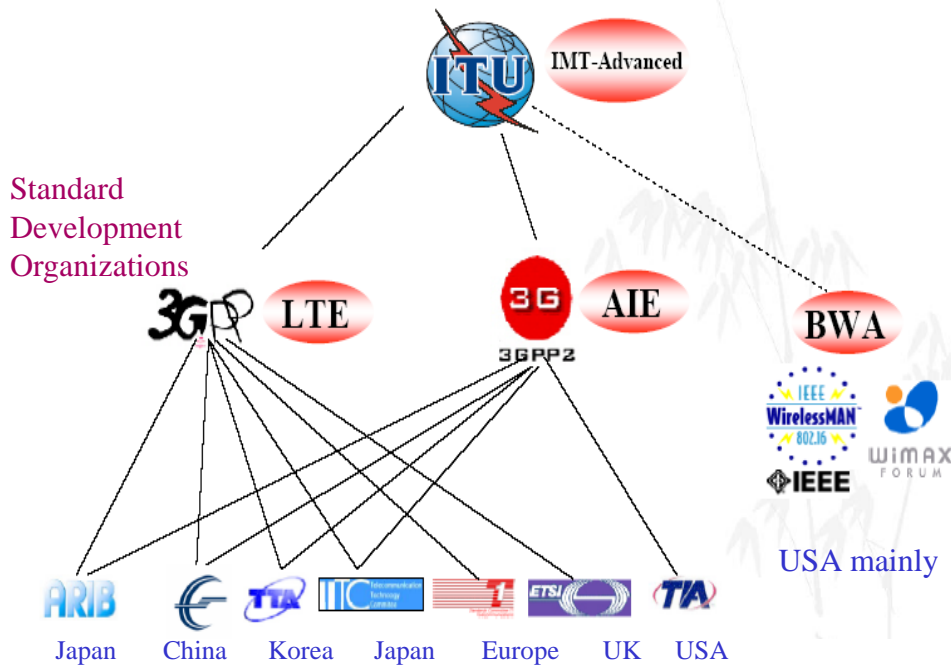
# Beyond 3G

- 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 range 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**

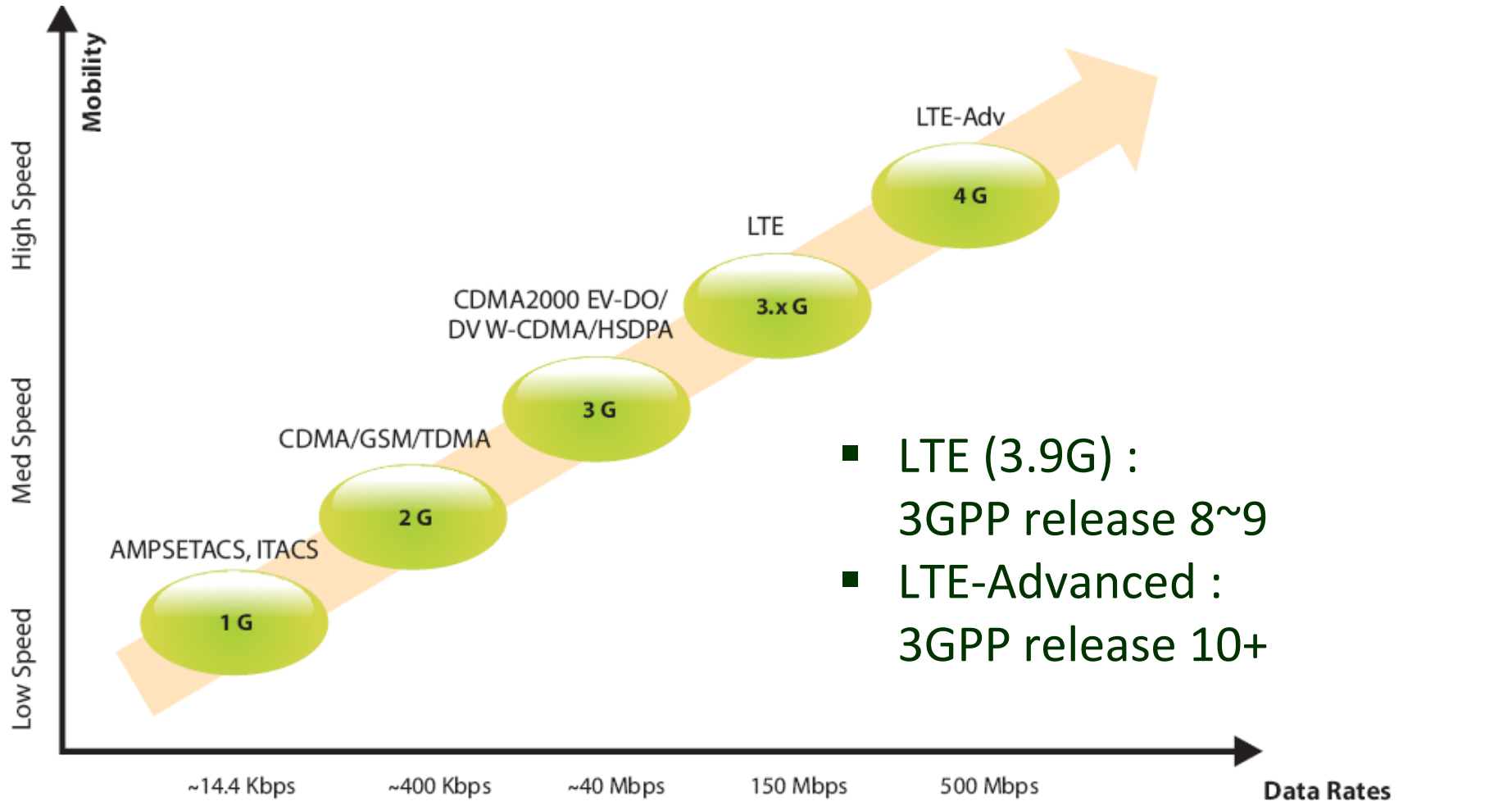
# Requirements for LTE

- 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



# 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

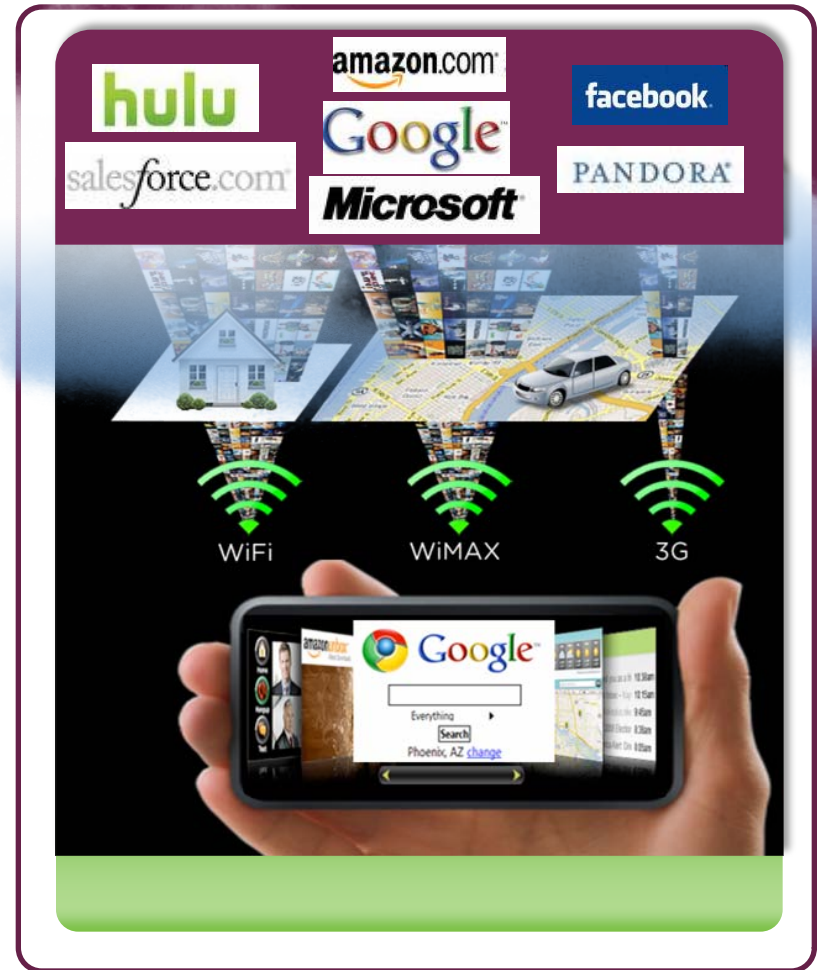
All their stuff in the palm of their hands 24x7.

Open ecosystem of applications, content and devices.

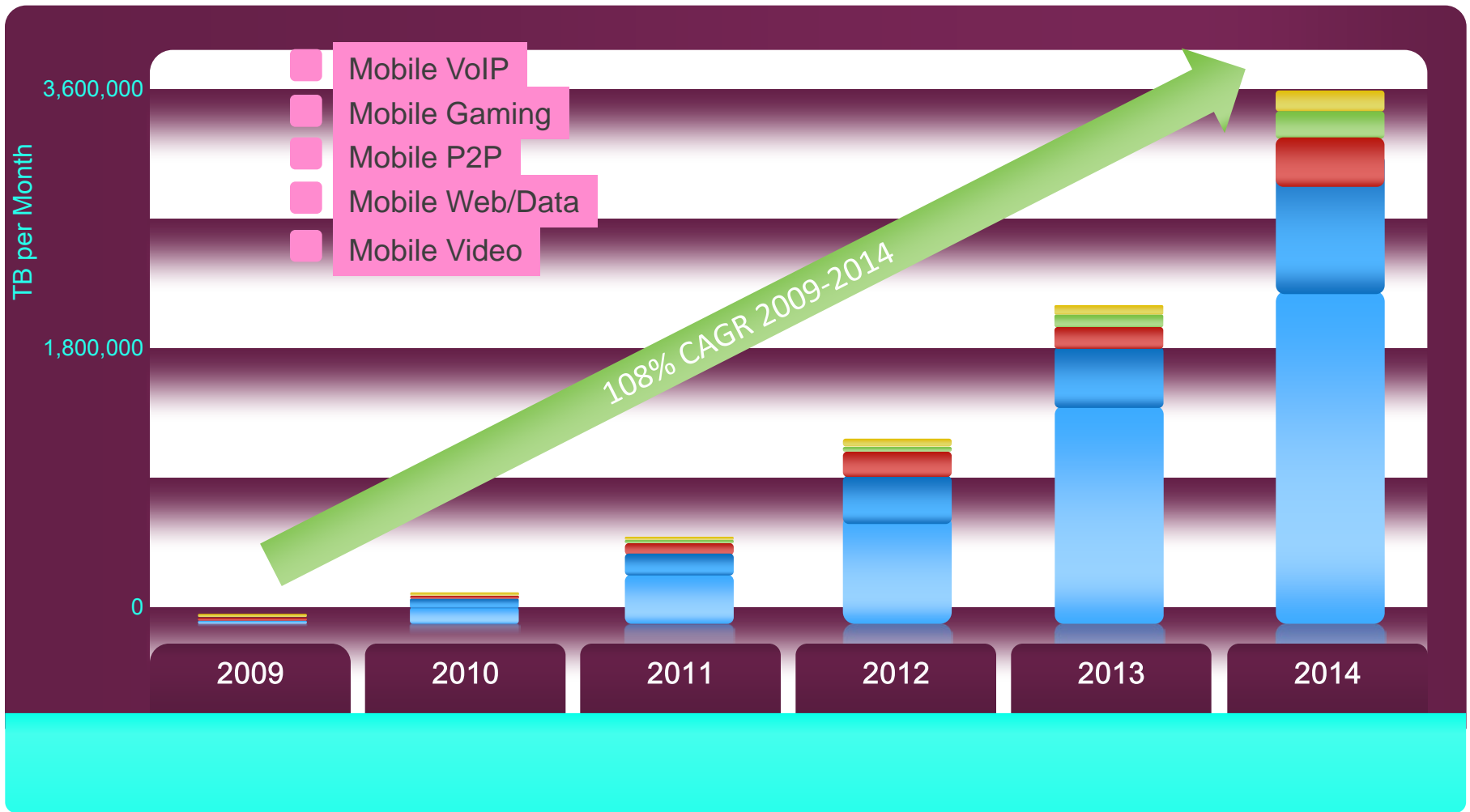
User generated content.

Business content.

Demands true broadband connectivity.



# Mobile Growth by Traffic Type



Source: Cisco VNI Mobile, 2010

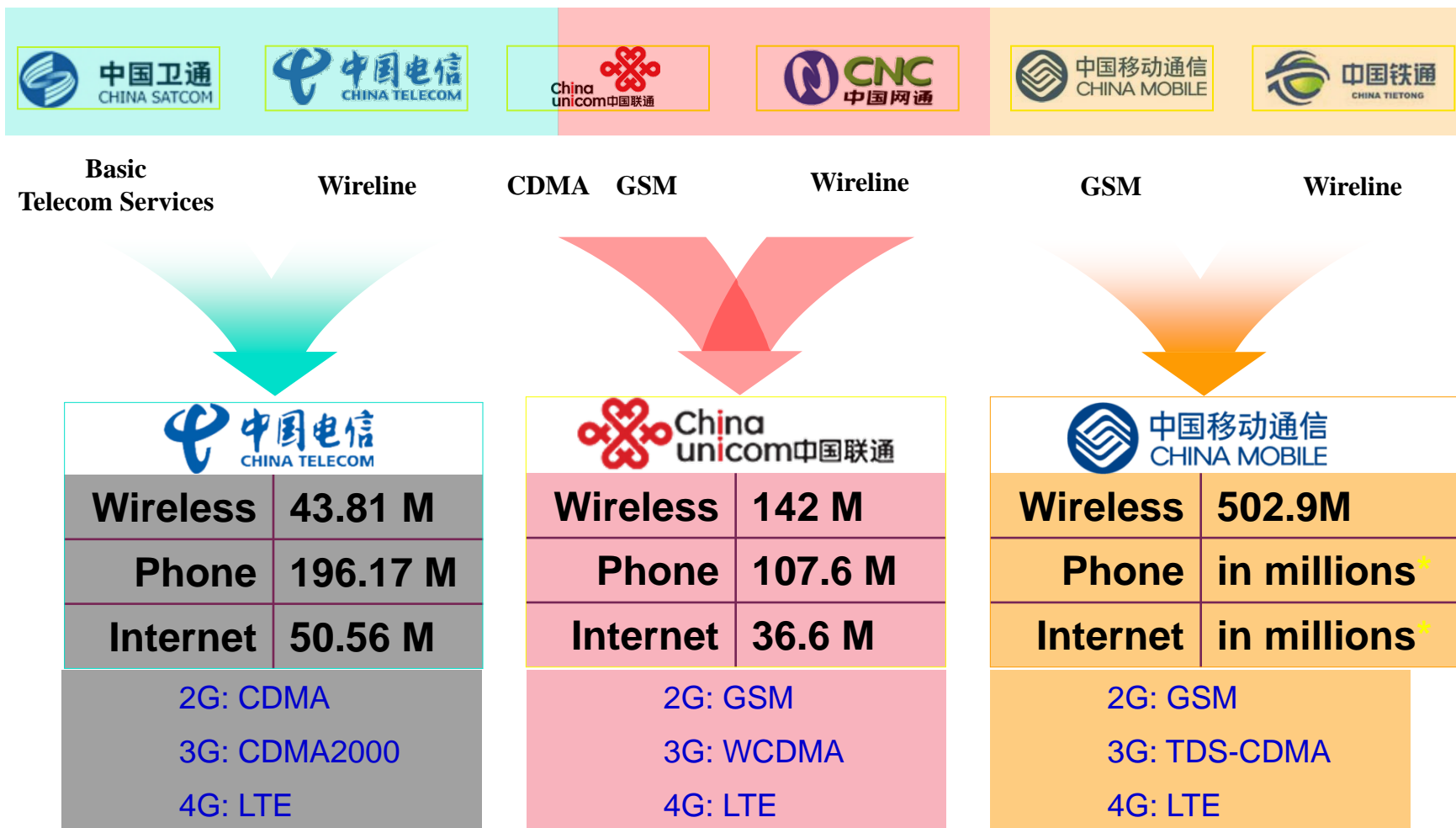
*Smartphones will outship the global notebook + netbook market in 2010 and the global PC market (desktop + notebook + netbook) in 2012.*

Morgan Stanley Mobile Internet Report



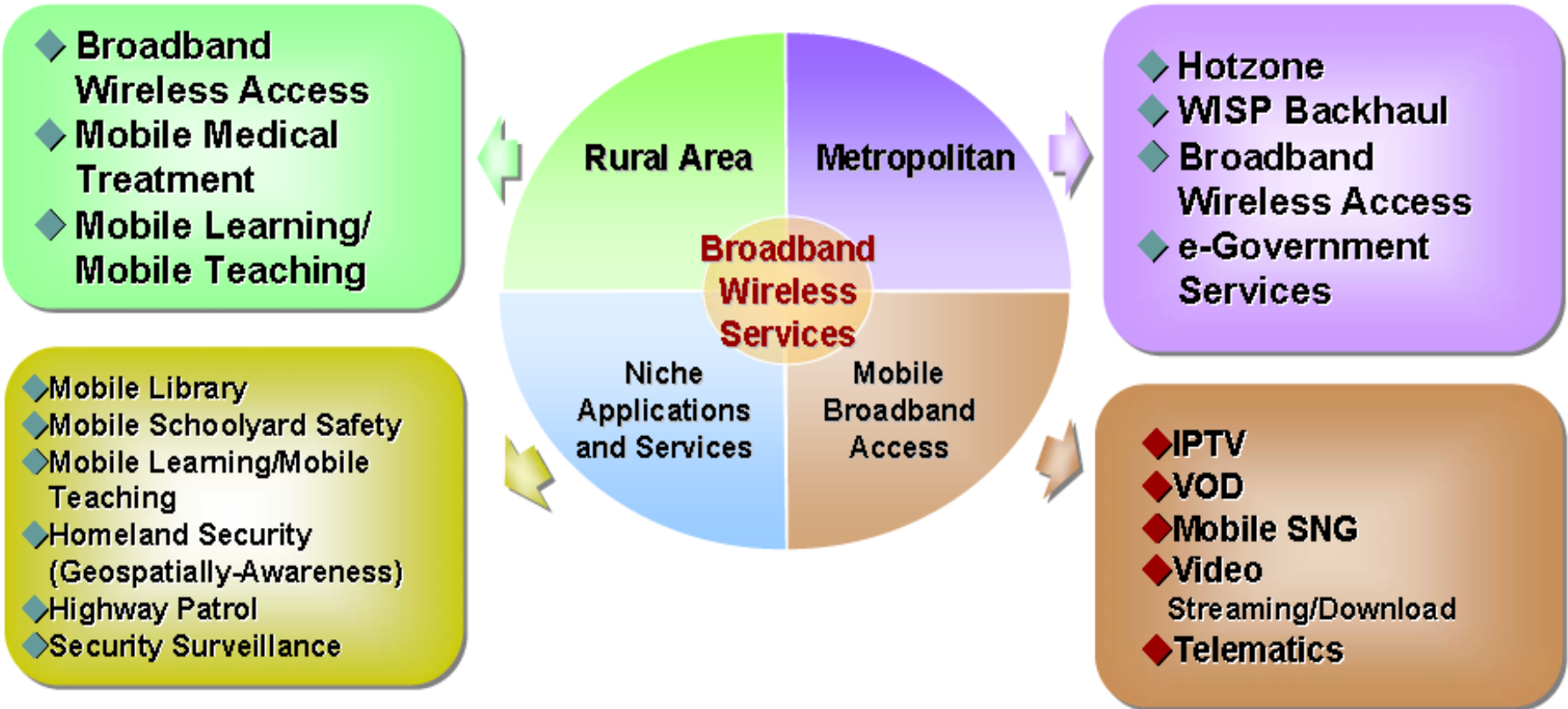
Morgan Stanley Mobile Internet Report

# 配合趨勢電信業者版圖整合 範例: China

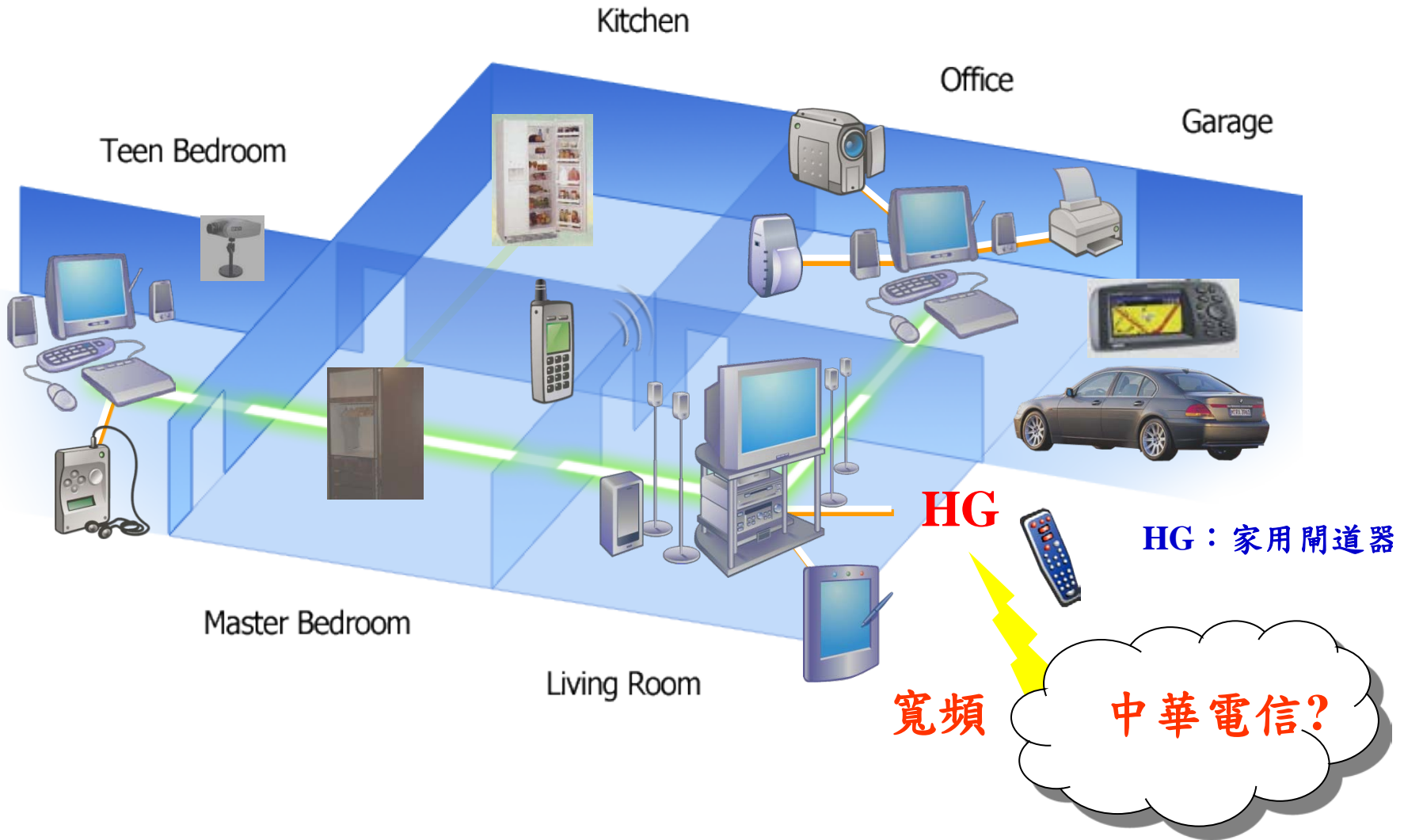


\* Till Aug 2009

# 寬頻無線上網服務應用



# 未來的戰場：家庭網路



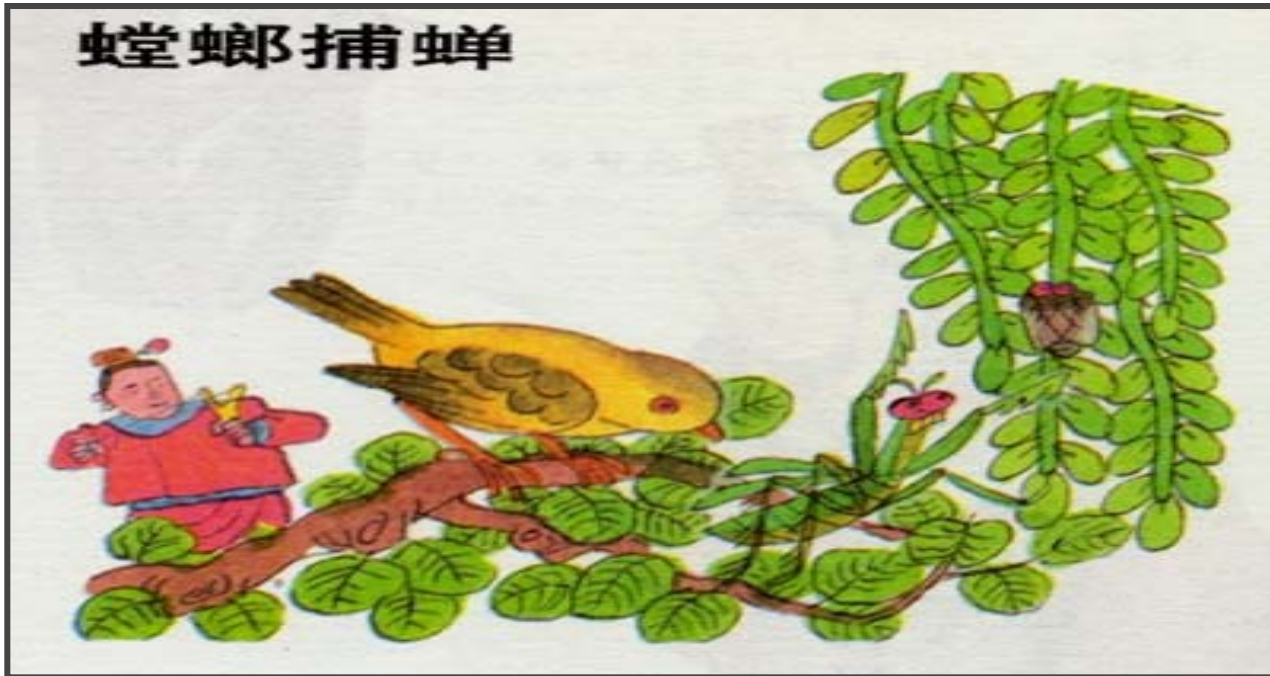
# Wireless Health

## **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**

**Re-purposed battery warehouse**

**Market**

**Price and incentive dispatch**

**Intelligent commercial building with demand response**

**Smart house with demand response**

**Clearer, more efficient base load generation**

**BENEFITS**

- Enhanced energy security
- Reduced greenhouse gases
- Improved urban air quality
- Increased grid asset utilization

**"Valley Filling" (Energy for PHEVs)**

Hours of day: 0, 12, 24

Category	Before PHEV	After PHEV
CO <sub>2</sub> Emissions	High	Low
Urban Emissions	High	Low
Electricity Sales	Low	High
Infrastructure Requirements	High	Low
Utility Rates	High	Low

**Public, Northeast National Laboratory**

**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

**Countdown of plug-in hybrids will increase the use of domestically produced electricity and can ultimately reduce greenhouse gas emissions by up to 100 million tons per year.** – EPA

**"Barely 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

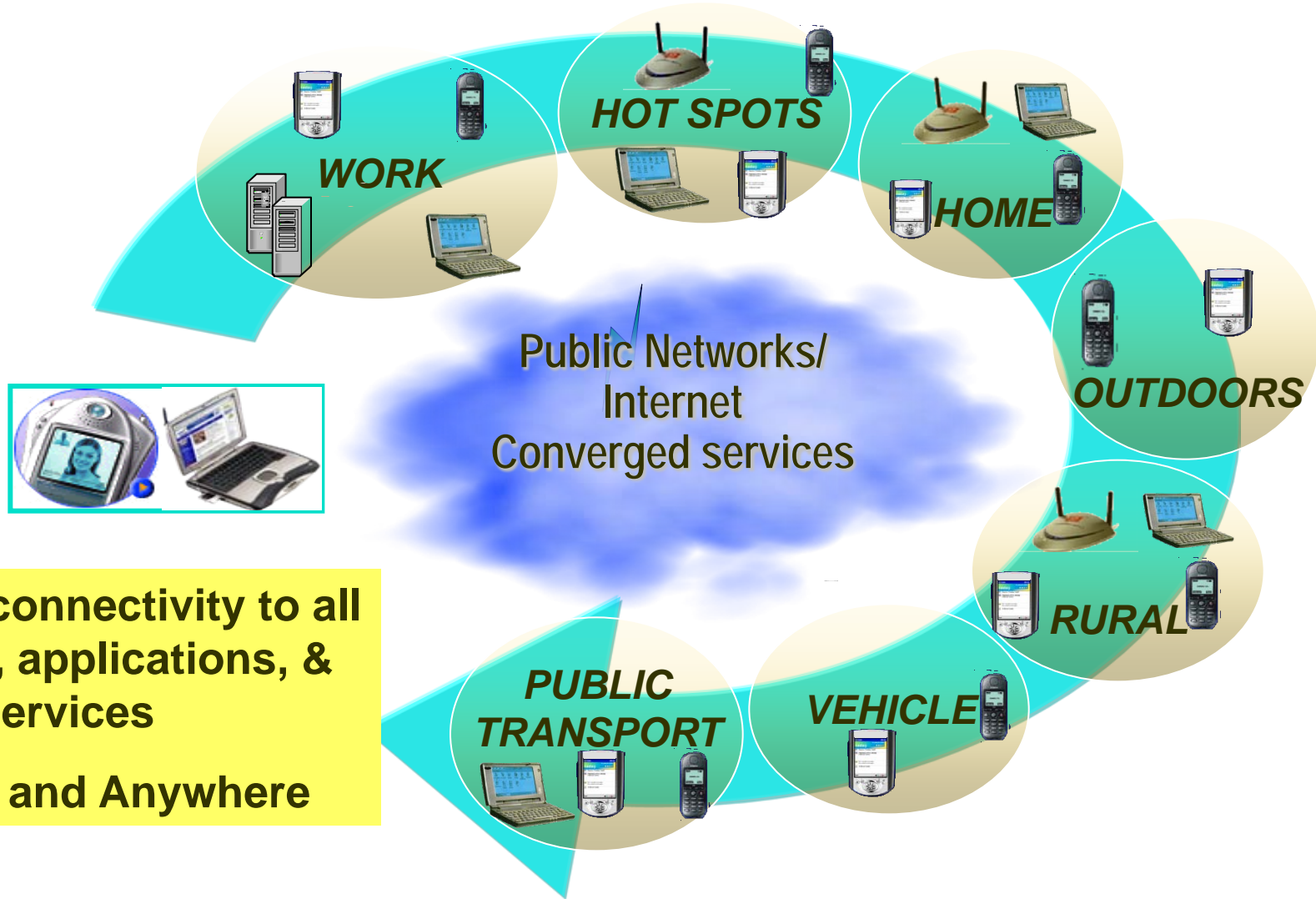
**"Working with automakers and local utilities, we need to understand how large numbers of PHEVs will be used, and their effect on the grid."** – University of Michigan

<http://totaleclipsed.hypermart.net/>



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

# *Wireless Future : A Seamless Mobile Lifestyle*



# *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?