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# The Value of 4G

## *Expanding and Exploiting the Value of Mobile Communications with 4G/LTE*

**Keith Mallinson**
**Founder, WiseHarbor**

Wragge & Co, London, September 2012

# Outline

- **Mobile market growth with new technologies, software applications and services**
- **Innovation with standard-essential patents (SEPs) and other intellectual property (IP)**
- **Ecosystem wars: reward sharing and economic rent seeking by innovators and implementers with FRAND-based and other intellectual property licensing**

# Key Factors for Fixed and Mobile Internet Usage

1. Network speed
2. Network latency
3. Device processor performance
4. Device software including browsers
5. Display size, color, resolution and video performance
6. Other device issues: keyboard/input, power consumption
7. Diversity of applications and content online
8. Attractive pricing for users
9. Viable business models for suppliers

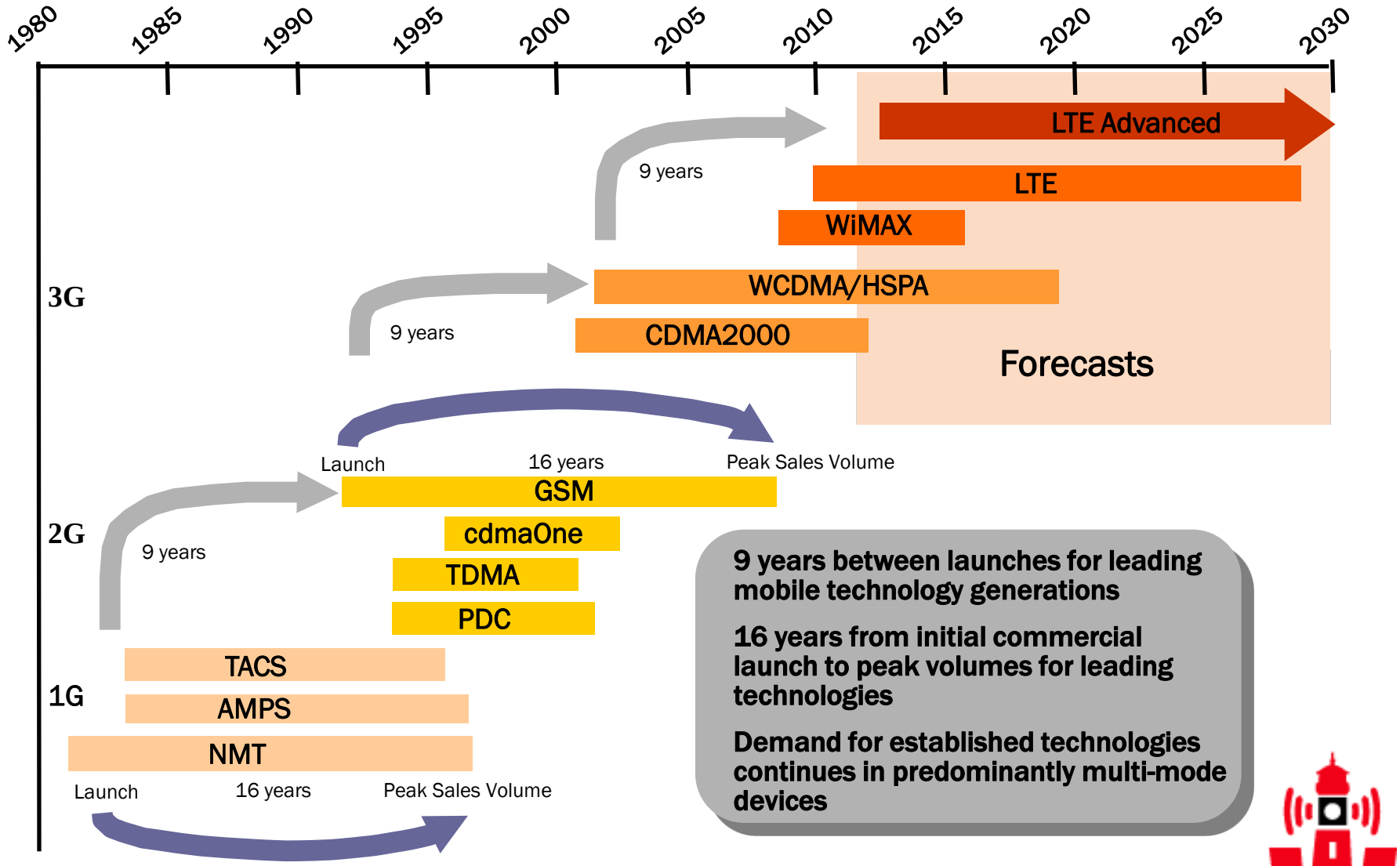
# Handset Evolution to 3G

| Introduced | 2001 | 2001 | 2002 | 2003 | 2004 | 2007 | 2011 |
|---|---|---|---|---|---|---|---|
| |  |  |  |  |  |  |  |
| Model | Motorola V60 | Ericsson T68 | Nokia 7210 | BlackBerry 7230 | Motorola RAZR V3 | Apple iPhone 2G | Apple iPhone 4S |
| Display(s) | Monochrome graphic 96 x 64 pixels Second: monochrome | 1.7" STN 256 colors 101 x 80 pixels | 1.5" CSTN 4,096 colors 128 x 128 pixels (121 ppi) | 2.6" TFT reflective 65,000 colors 240 x 160 pixels (111 ppi) | 2.2" TFT 256,000 colors: 176 x 220 pixels Second: CSTN 4,096 colors | 3.5" TFT capacitive touchscreen 16,000,000 colors 320 x 480 pixels (165 ppi) | 3.5" LED-backlit IPS TFT, capacitive touchscreen 16,000,000 colors 690 x 960 pixels (330 ppi) |
| Data | 2G GPRS 32-40 kbps | 2G GPRS 24-36 kbps | 2G GPRS 24-36 kbps | 2G GPRS (<56kbps) | 2G GPRS (38-42 kbps) | 2G EDGE (<300kbps) WiFi | 3G HSDPA 14.4 Mbps 3G HSUPA 5.8Mbps WiFi |
| Features | SMS, WAP 1.1 browser, games | SMS, MMS, Email, WAP 1.2.1 | SMS, MMS, WAP 1.2.1 browser, games | SMS, Email, BlackBerry HTML browser Qwerty keyboard | SMS, MMS, Email, WAP 2.0/ xHTML browser Video player 0.3MP camera | SMS, Email, HTML Safari Video player 2MP camera 412 MHz CPU | SMS, Email, HTML Safari HD 1080p video @ 30 fps 8MP camera Dual core 1GHz CPU |

# 4G Devices

| Introduced | 2012 | 2012 |
|---|---|---|
| |  | iPad 3  |
| Model | Motorola DROID 4 | Apple iPad 3 |
| Display | 4.00" TFT<br>16M colors<br>540 x 960 pixels (275ppi) | 9.7" IPS LCD capacitive touchscreen<br>16M colors<br>2048 x 1536 pixels (264 ppi) |
| Processors | Dual core, 1.2GHz TI OMAP4430 | Dual core, 1 GHz, Apple A5X and Quad core PowerVR SGX543MP4 for graphics |
| Data | LTE 700 MHz Class 13,<br>CDMA EV-Do Rev A | LTE 700 MHz Class 17, 1700/2100 MHz<br>HSDPA+ (42.2Mbps), UMTS, EDGE, GPRS |
| Features | Android 2.3.5, HTML5, Flash, 8MP and 1.3MP cameras, accelerometer, gyroscope and barometer | iOS 5.1, HTML5, 5MP and 0.3MP cameras, accelerometer, gyroscope, compass and voice commands |

# Mobile Technology Adoption Lifecycles – From Launch to Peak Demand

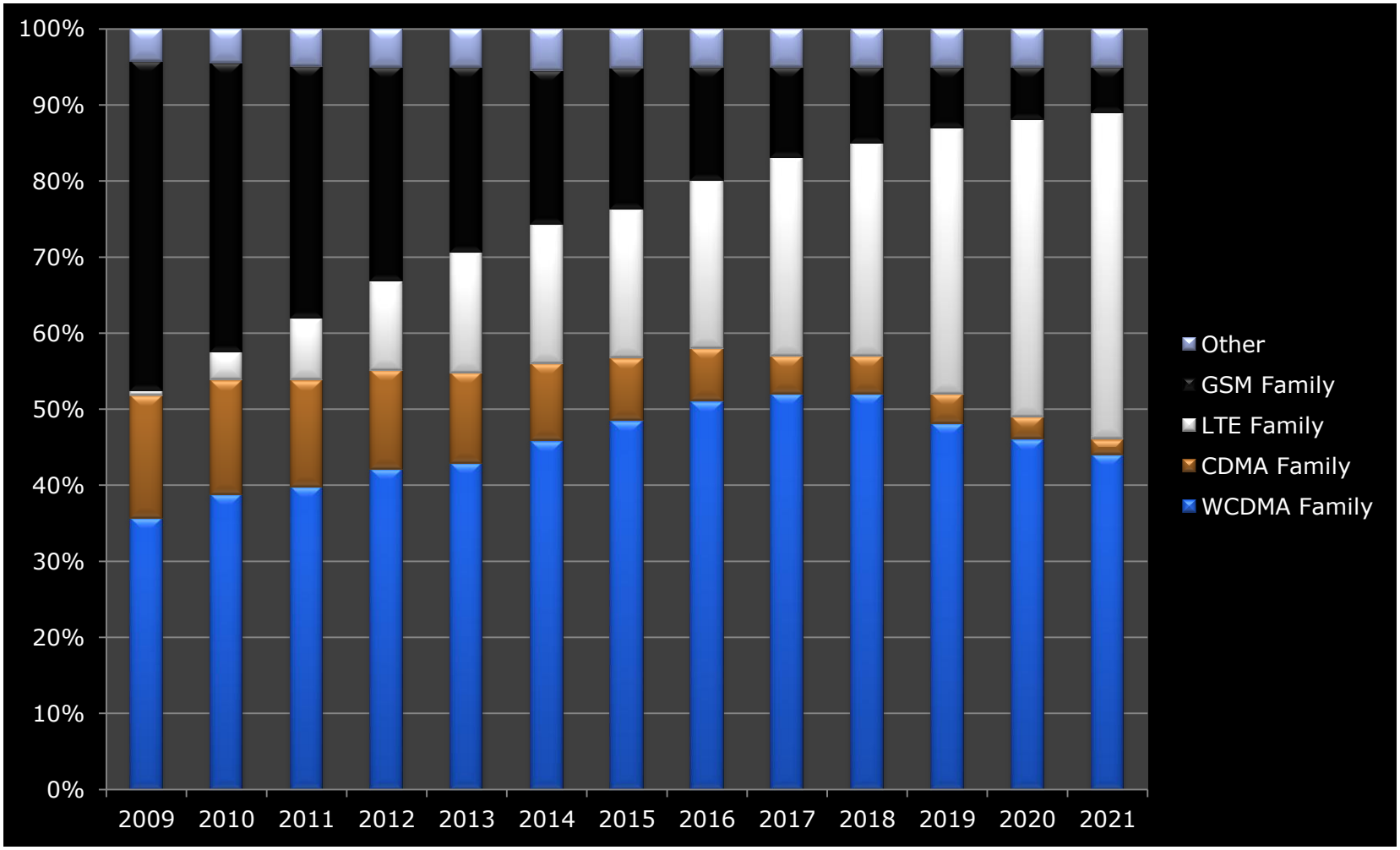



**9 years between launches for leading mobile technology generations**

**16 years from initial commercial launch to peak volumes for leading technologies**

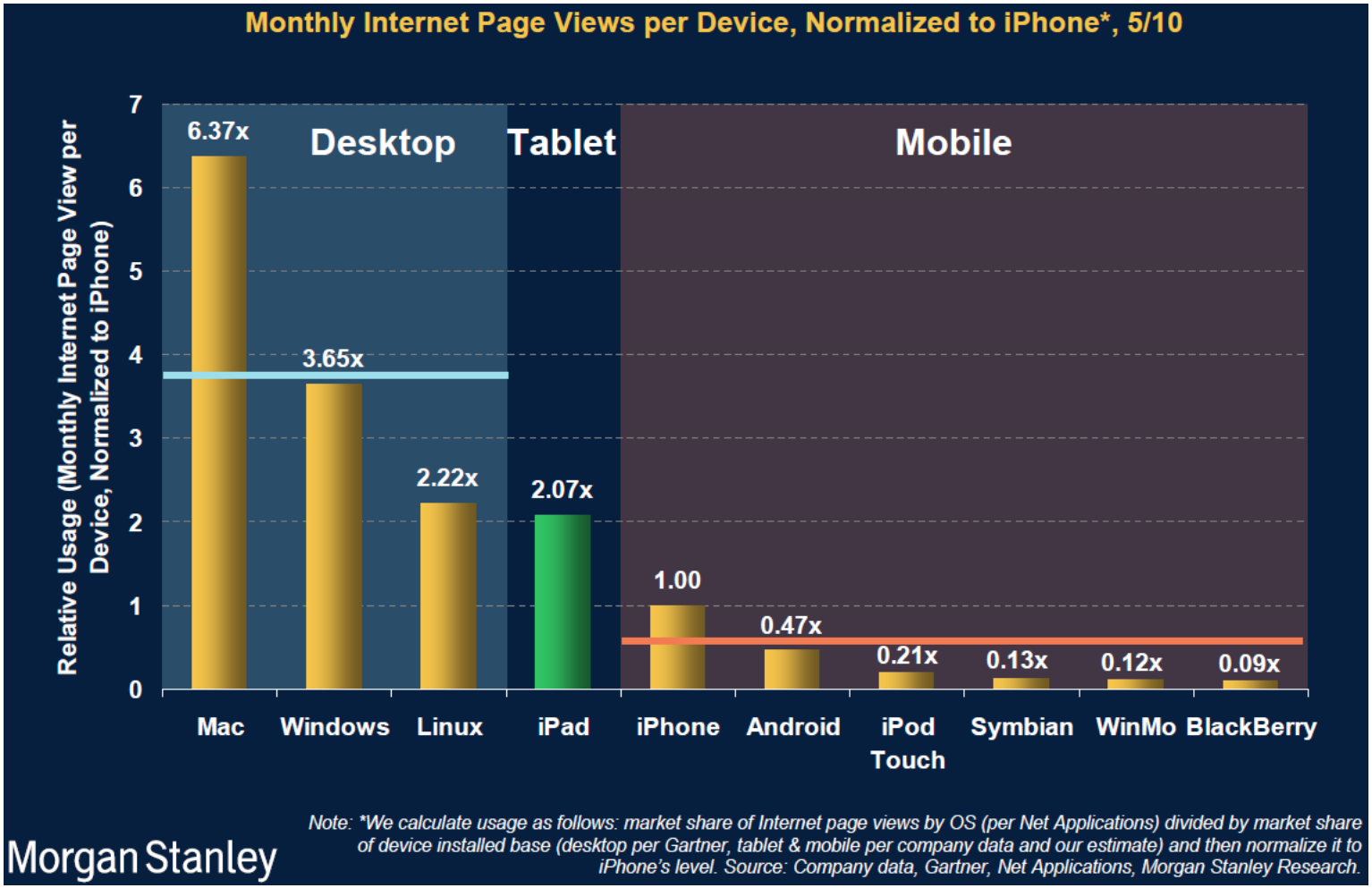
**Demand for established technologies continues in predominantly multi-mode devices**

# LTE Migration – Share of Network Spending




Source: WiseHarbor Forecast, 2011

# Tablet and Mobile versus Desktop Internet Use

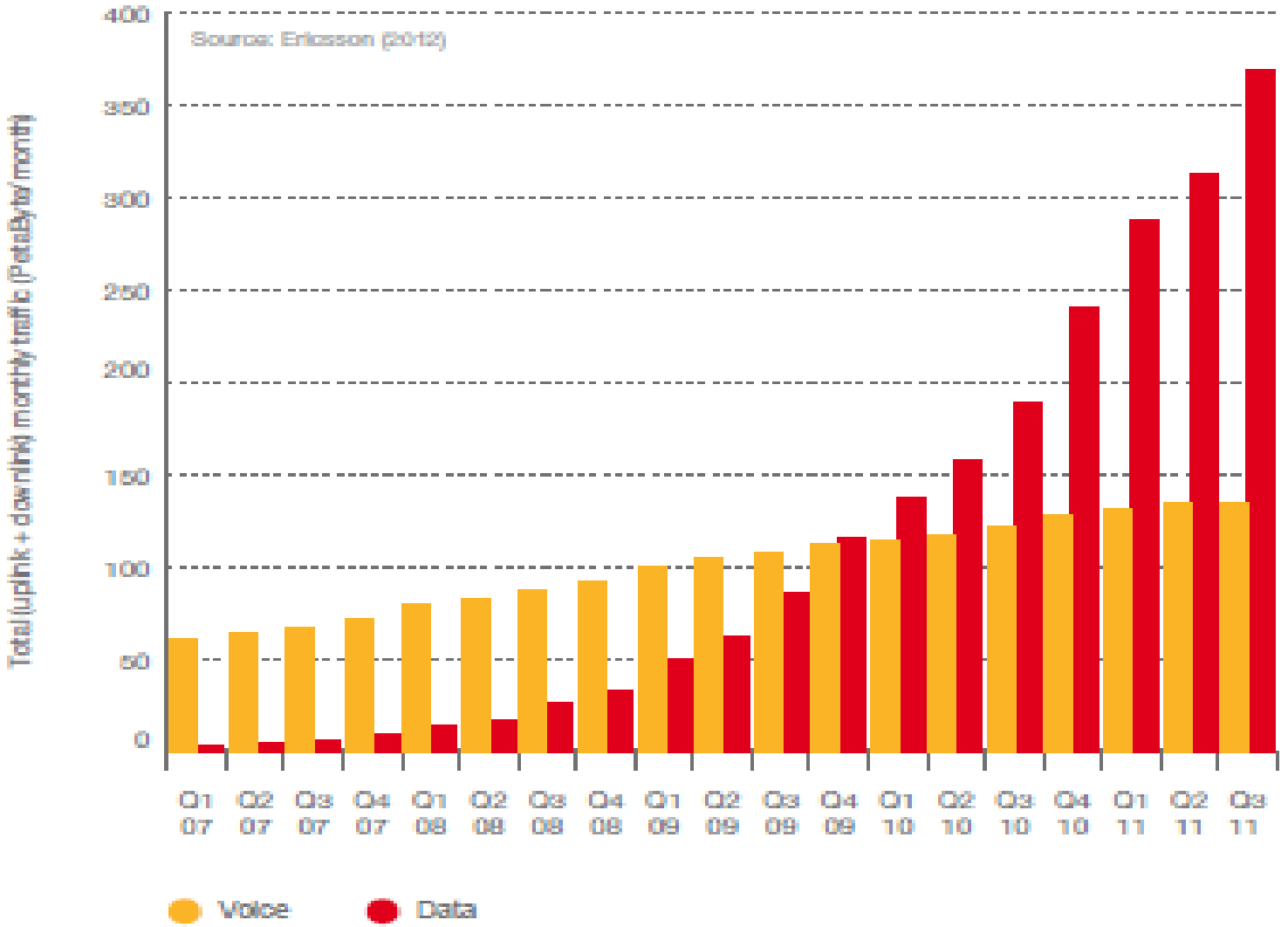


# Average Time Spent per Day with Major Media by US Adults, 2008–2011

| (minutes ) | 2008 | 2009 | 2010 | 2011 |
|---|---|---|---|---|
| TV and Video | 254 | 267 | 264 | 274 |
| Internet | 137 | 146 | 155 | 167 |
| Radio | 102 | 98 | 96 | 94 |
| Mobile | 32 | 39 | 50 | 65 |
| Newspapers | 38 | 33 | 30 | 26 |
| Magazines | 25 | 22 | 20 | 18 |
| Other | 48 | 46 | 46 | 48 |
| **Total** | **635** | **650** | **660** | **693** |

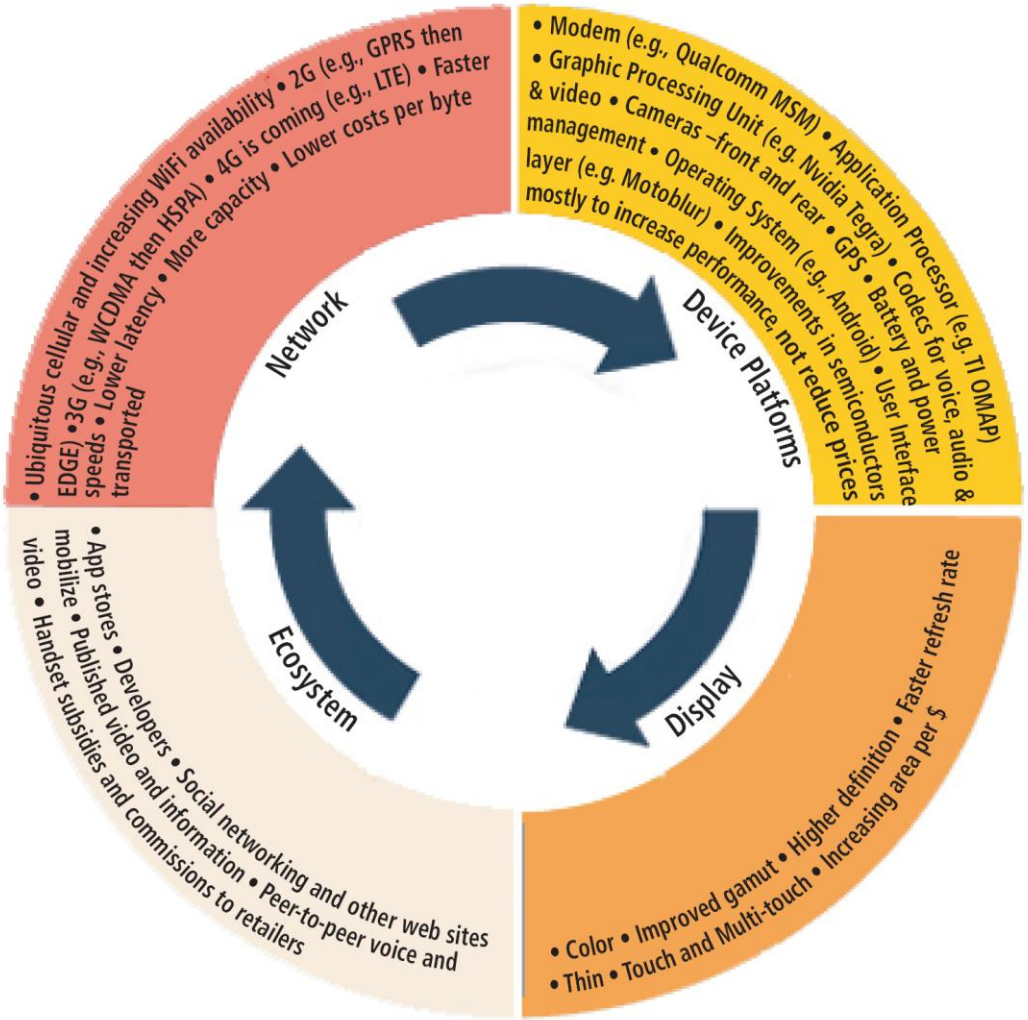
*Note:* Time spent with each medium includes all time spent with that medium, regardless of multitasking: for example, 1 hour of multitasking on the Internet and watching TV is counted as 1 hour for TV and 1 hour for Internet; numbers may not add up to total due to rounding.
*Source: eMarketer, Dec 2011*

# Total Global Traffic in Mobile Networks 2007–2011




*Source: Ericsson Traffic and Market Data Report, 2012*

# Virtuous Circle of Innovation, Adoption and Usage with Mobile Phones



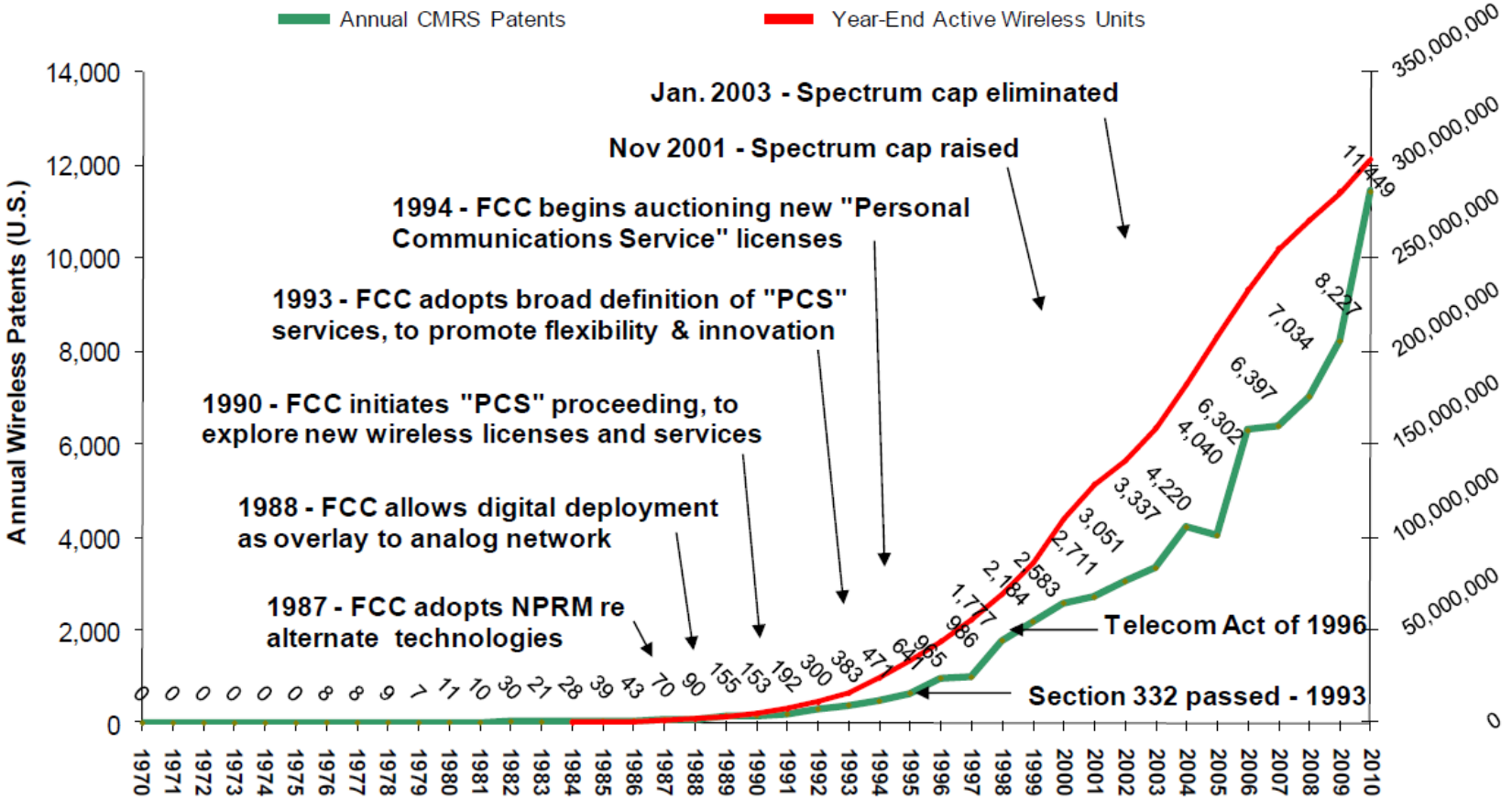

*Source: WiseHarbor article in FierceWireless Europe, February 2012*

# Smartphone IP is Everywhere

| Layer | Functions | Implementation | Notable IP owners |
|---|---|---|---|
| **Radio** | Modem protocols including GSM, CDMA, HSPA, LTE | Dedicated silicon baseband processors running microcode or software defined radios on more general purpose processors | Ericsson, Nokia, Qualcomm, InterDigital, Motorola/Google, Samsung, LG (the list of claimants is growing) |
| **Multimedia** | Speech vocoders, video recording/playing codecs, graphics engines | Dedicated silicon Graphics Processing Units with hardware acceleration or software acceleration | Various ICT companies. Patent pool administrator MPEG LA lists 29 licensors for the AVC/H.264 video standard |
| **Operating System Platform and User Interface** | The device's management system and human interface | Software on general purpose applications processors with voice recognition, text-to-speech and innovative hardware such as touch-screen controllers | Google (Android*), Apple iOS, Windows Phone (Microsoft), Nokia (Symbian), RIM, WebOS |
| **Applications** | Various | Software that is typically obtained in the aftermarket | Numerous. Rovio's Angry Birds is a popular game |
| **Physical design** | Aesthetic style, ergonomics | Hardware form factor and layout | Handset manufacturers. Apple is asserting its design IP |
| **System design** | Apps stores, content delivery, service management, billing | External to device including network, service provisioning and third party content providers | Various, including Apple, Google and mobile operators |

**Open source software has nominally somewhat common ownership. However, it can be under significant control of its leading sponsor(s) while being fragmented with vendor-specific implementations (e.g., with Motorola's proprietary Motoblur UI replacement, HTC's Sense and Kindle's Fire)*

# Patented Innovation in U.S. Cellular

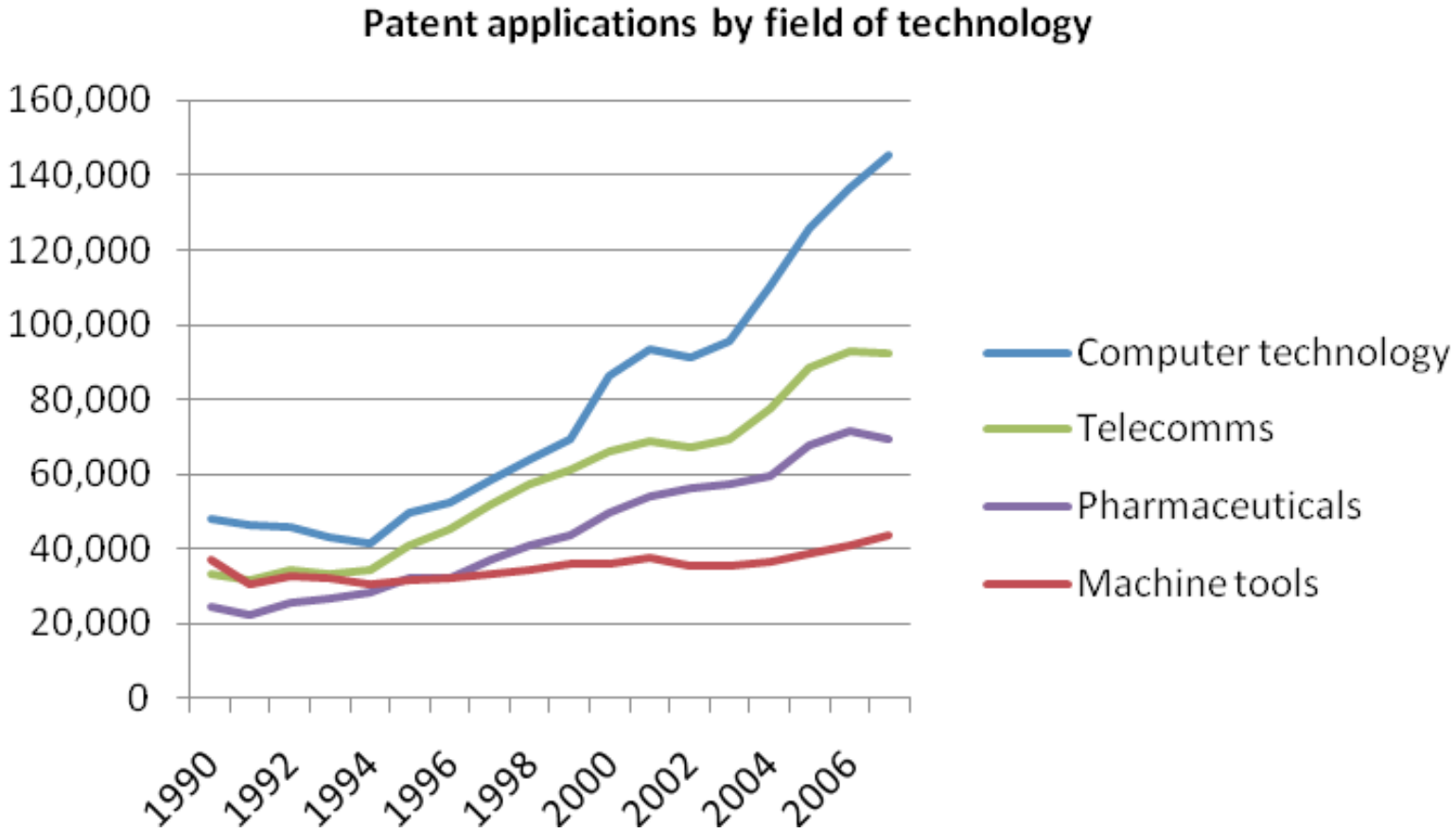



Sources: U.S. Patent Office, CTIA Research

# Some Say "Strategic Patenting" is Problematic

## "Which Technologies are Causing the Problem?"

(allegedly from patent "thickets" and "hold-up" with "sequential" and "complementary" innovation)




*Source: Digital Opportunity: A Review of Intellectual Property and Growth, May 2011, by Professor Ian Hargreaves, based on WIPO Statistics Database, September 2010*

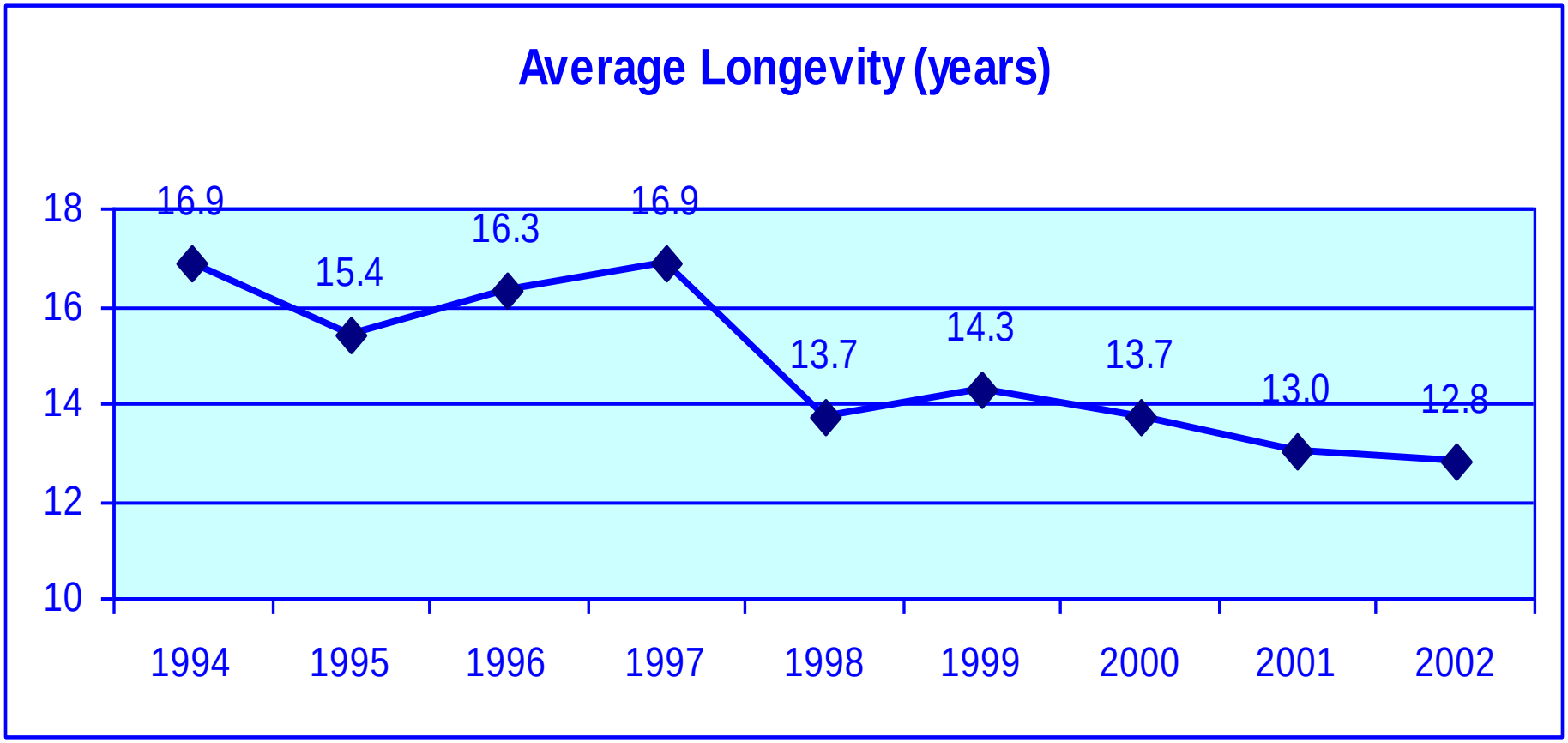
# Pharma is not Unique

| | R&D/Sales | Annual R&D (millions) | Gross Profit Margin |
|---|---|---|---|
| **Roche** | 18.1% | CHF 8,266 ($8,640) | 73.0% |
| **Pfizer** | 11.0% | $7,766 | 82.3% |
| **Novartis** | 16.0% | $9,518 | 67.8% |
| **Merck** | 16.2% | $7,834 | 77.2% |
| **Pharmaceutical Average** | 15.3% | | 75.1% |
| | | | |
| **Microsoft** | 14.4% | $9,811 | 76.9% |
| **SAP** | 15.2% | $2,064 | 67.6% |
| **Oracle** | 11.2% | $4,523 | 81.6% |
| **Red Hat** | 19.0% | $220 | 85.4% |
| **Software average** | 15.0% | | 77.9% |

*Source: Google Finance*

*See "Why there are too many patents in America" by Judge Richard A. Posner, July 2012*
*http://www.theatlantic.com/business/archive/2012/07/why-there-are-too-many-patents-in-america/259725/*

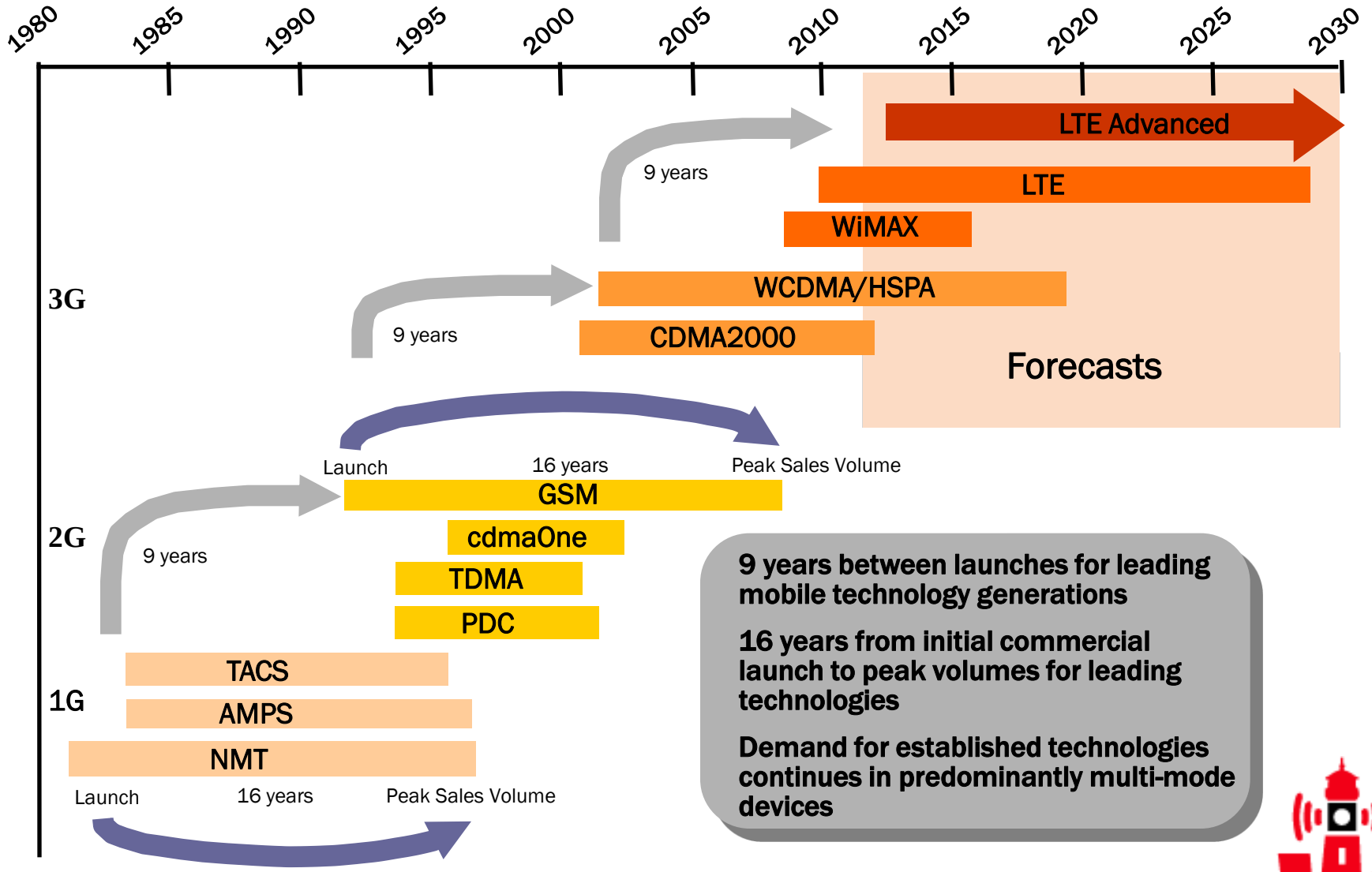
# Pharmaceutical Product Longevity*




*"Time from first launch to peak sales"

*Source: John Ansell Consultancy (2003)*

# Mobile Technology Adoption Lifecycles – From Launch to Peak Demand




**9 years between launches for leading mobile technology generations**

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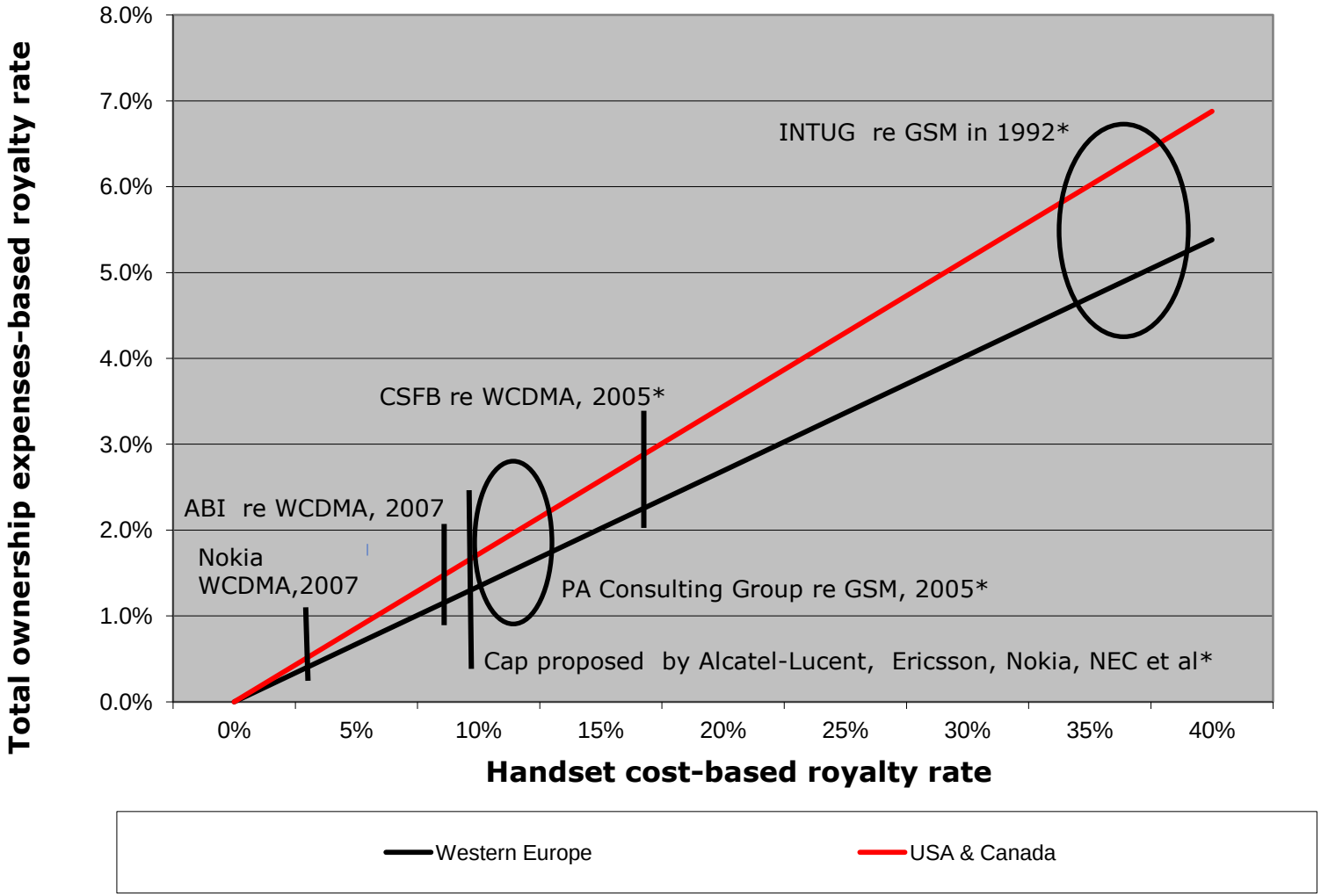
# Major FRAND Patent Licensing Successes

- **Video Codecs**
  - Widely used in DVDs, broadcast streams, PCs and smartphones
  - 29 voluntary licensors and 1,000 licensees to H.264 patent pool
  - Efficiently administered by pool supported by patent examiners
  - Proprietary and open source software (eg, x.264) implementations
  - Aggregate patent royalties averaging approximately $3 per device

- **Mobile Phones**
  - 5 billion phones in a $1 trillion market including services
  - Prices down to $20 (unsubsidised)
  - Most vibrant and innovative market with smartphone revolution
  - Data speeds 1,000 faster in 10 years from 56kbps GPRS in 2000
  - Hundreds of companies contribute to 3GPP and 3GPP2 standards
  - 10 major standards releases by 3GPP and pace increases
  - Aggregate royalty rates have declined

# Royalties Increasingly Reasonable

## Aggregate royalty rates based on total ownership expenses




** For companies with no IP to cross-license*

# Average Cost of Ownership for Cellular

| 2011 figures | US and Canada | Western Europe |
|---|---|---|
| Average service revenue per user (per month) | *$50 | $32 |
| Service life (in months) | 20 | 34 |
| Total operator services expenditures | $1,001 | $1,087 |
| Average unsubsidised wholesale phone price | **$207 | **$167 |
| Total lifecycle expenditures | $1,208 | $1,254 |
| Handset cost/total expenditures | 17% | 13% |

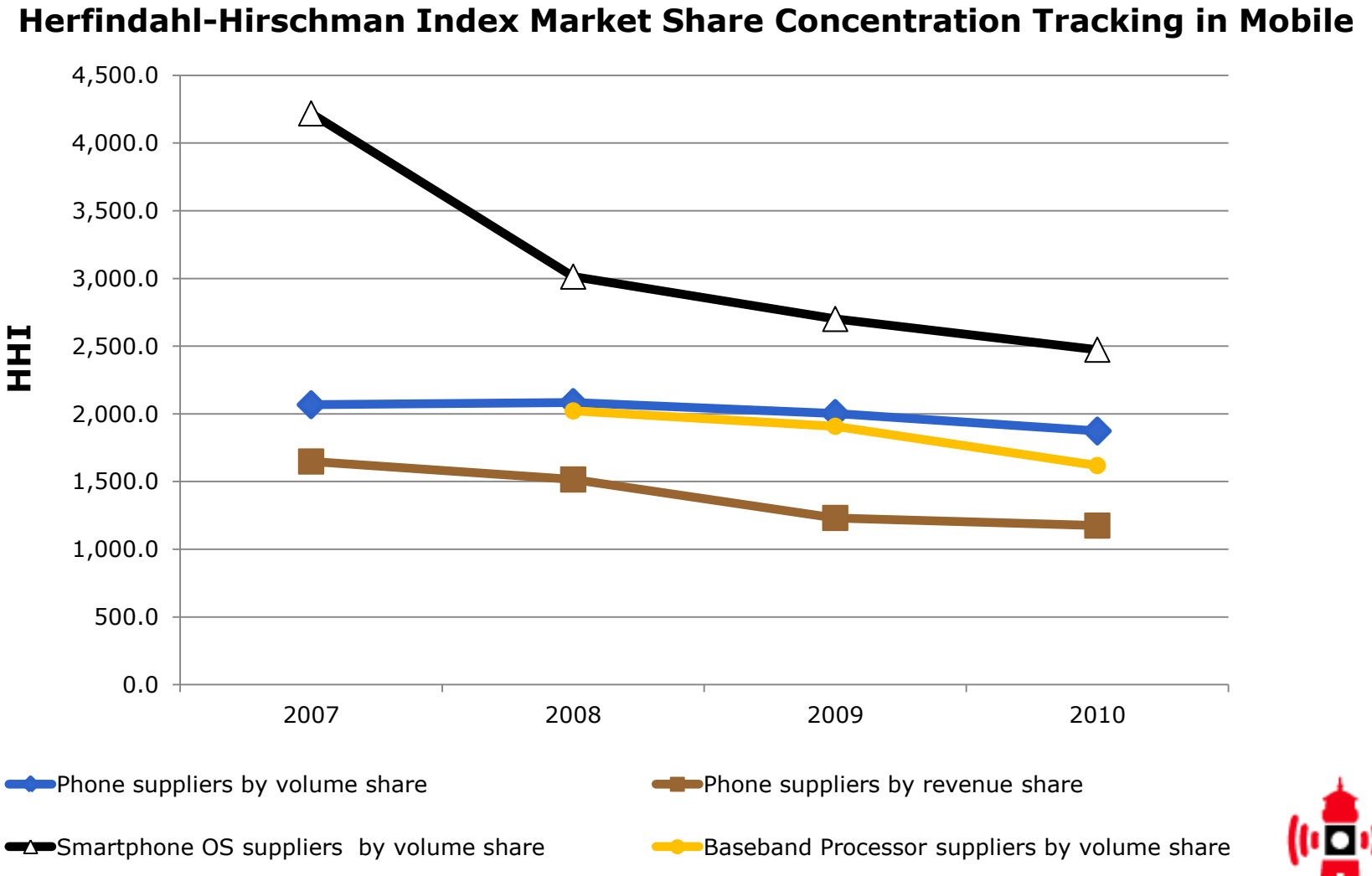
** Average price per minute in U.S. has reduced 15% per annum since 1993*
*** Wholesale handset prices have reduced an average of 8% per annum since 1993*

# Competition: Herfindahl-Hirschman Index

- **Measures market share concentration**
  - The HHI is calculated by squaring the market share of each firm competing in a market, and then summing the resulting numbers
  - The HHI number can range from close to zero to 10,000. The closer a market is to being a monopoly, the higher the market's concentration and the lower the level of competition.
  - If, for example, there were only one firm in a market, that firm would have 100% market share and the HHI would equal 10,000 (i.e., 100 x 100)
  - Alternatively, if there were thousands of firms competing, each with close to 0% market share, the HHI would be close to zero, representing near "perfect competition"

- **According to the U.S. Department of Justice:**
  - "[M]arkets in which the HHI is between 1,000 and 1,800 points are considered to be moderately concentrated, and those in which the HHI is in excess of 1,800 points are considered to be concentrated"

# Competition: Market Supply is Unconcentrated



# Increasing Choice

## Handset Manufacturers and Handset Models Offered, U.S., 2006-2010

| Reporting Handset Manufacturers | 2006 (Nov) | 2007 (Nov) | 2008 (Dec) | 2009 (June) | 2010 (June) |
|---|---|---|---|---|---|
| *Total Number* | 8 | 12 | 12 | 16 | 21 |
| Total Number Offering Ten or More Handset Models | 5 | 8 | 8 | 9 | 11 |
| Total Number of Handset Models Offered | 124 | 168 | 316 | 260 | 302 |

*Source: U.S. Federal Communications Commission, 2011*

# Vendors Who Have Publicly Declared LTE Rates

| | Vendor's Own Estimate of its Essential LTE IPR | Expected Handset Royalty Rate |
|---|---|---|
| **Nokia** | **20-30%** | **1.5% (2%*)** |
| **Nokia Siemens Networks** | **10-15%** | **0.8%** |
| **Ericsson^** | **20-25%** | **1.5%** |
| **Motorola** | | **2.25%** |
| **Nortel Networks** | | **1%** |
| **Alcatel-Lucent** | | **≤2%** |
| **Qualcomm** | | **3.25%** |
| **Huawei** | | **≤1.5%** |
| **ZTE** | | **≤1%** |

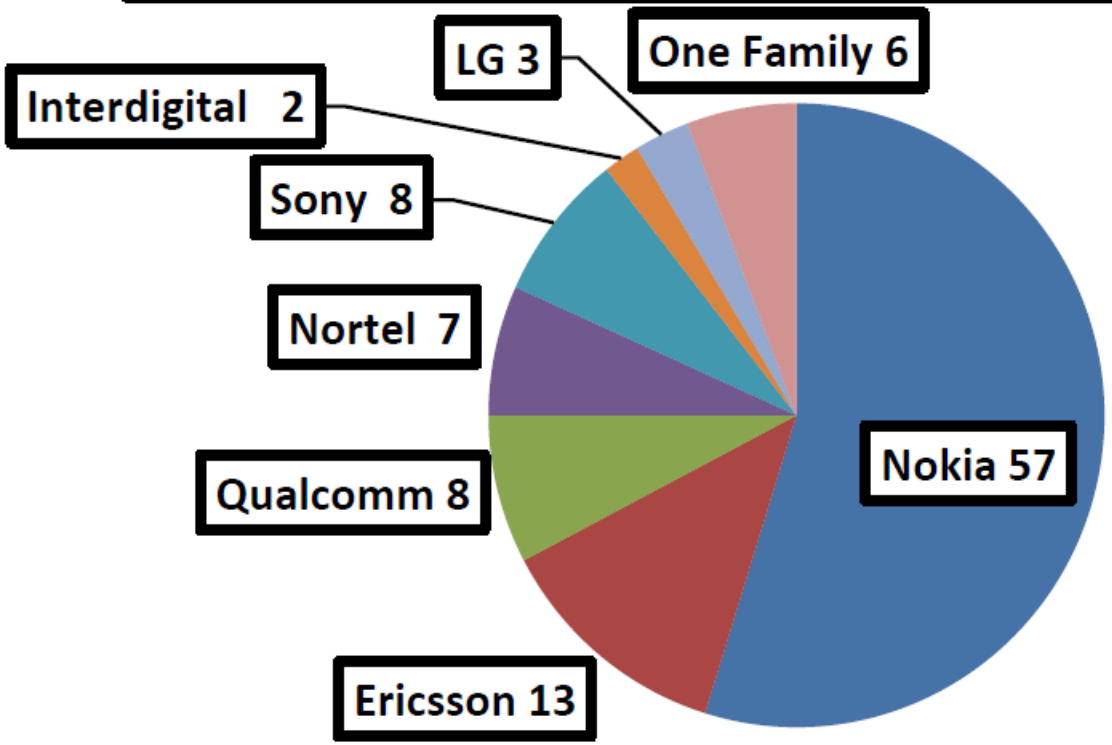
**Multi-standard devices*
*^Projected maximum aggregate royalty of 6-8%*

# Two "Essentiality" Assessment Studies on LTE

- ***Fairfield Resources – counts patent families judged essential***
  - *"Fairfield Resources has for more than six years, with support from Nokia and other wireless industry leaders, been studying the extent to which patents declared as essential to wireless standards actually are essential, as determined by a team of experienced wireless engineers.*
  - *The present report, using substantially the same team of experts as in our previous studies, extends our reviews to patents declared as essential to two fourth generation cellular technologies, LTE (the radio access interface) and SAE (the core network)"*

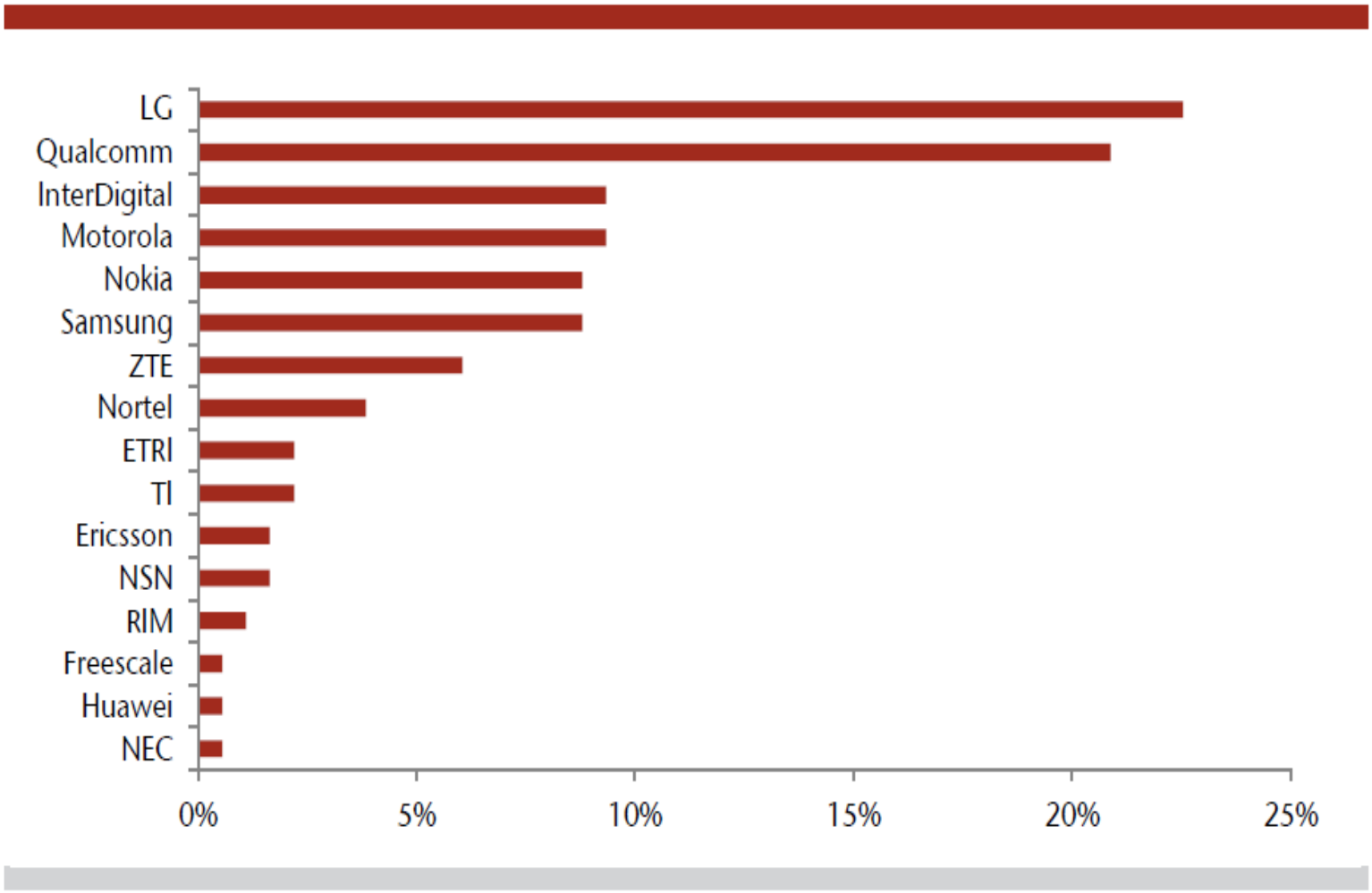
- ***Jefferies & Company – counts patents judged essential***
  - *"In valuing the essential LTE patent portfolios of major players in the wireless space, we utilized outside industry experts that included physics PhDs, wireless engineers, patent legal specialists, and former patent office employees.*
  - *Our work began by first screening tens of thousands of patents and then determined a level of essentiality based on individually examining over 1,400 patents related to LTE"*

# Families Judged Essential to LTE/SAE (105)




*Source: Fairfield Resources Study, 2010*

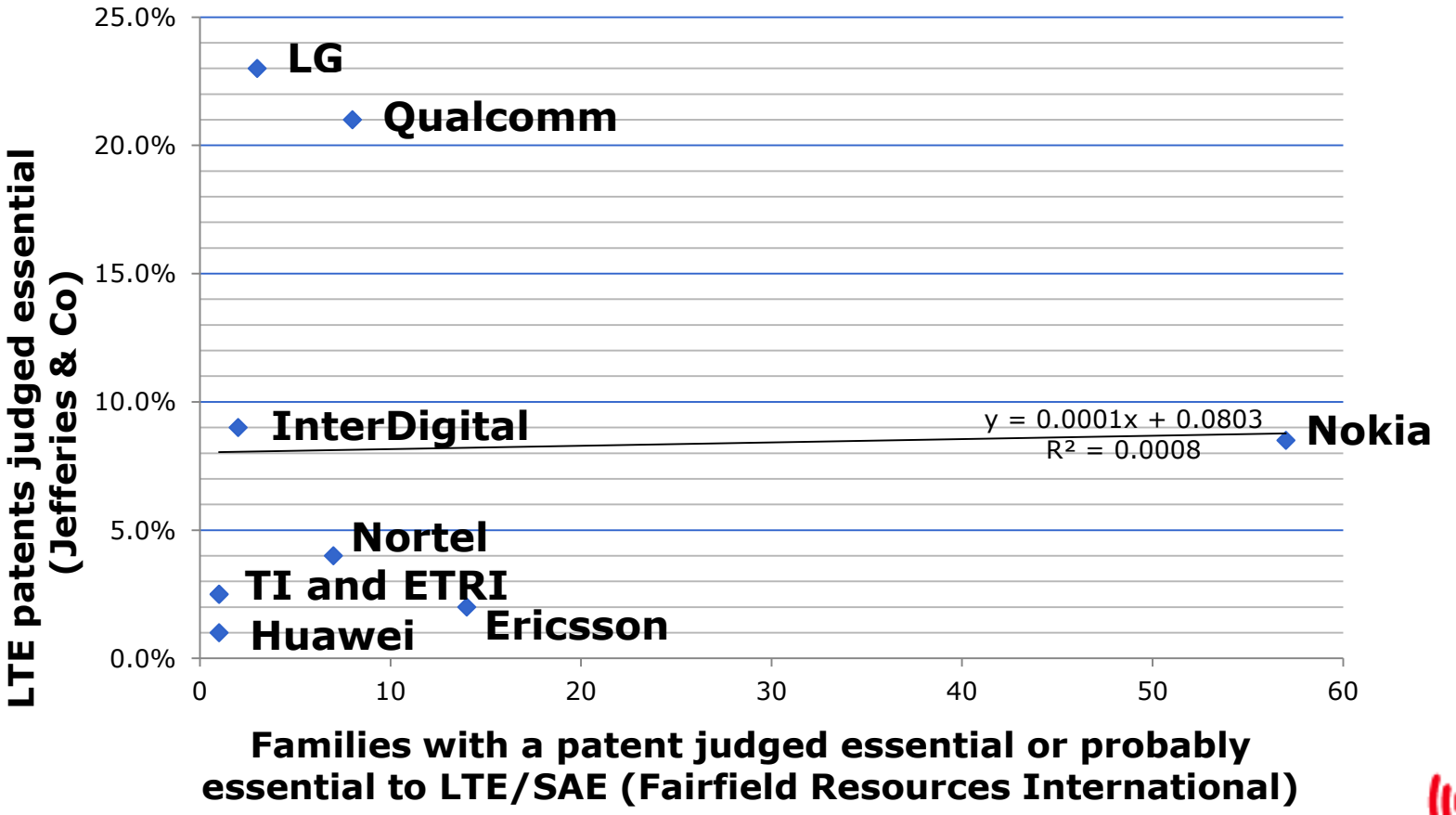
# (Judged) Essential LTE Patents




*Source: Jefferies & Co, September 2011*

# The Peril of Imposing Valuation Methods

**Disagreement on LTE Essential Patent Determinations: Regression shows extremely weak correlation between two studies' results ($R^2$=0.0008)**




*Nine companies including Motorola, Samsung, RIM and ZTE are absent because they were only registered as having essential patents in one of the two studies*

# Some Conclusions

- **FRAND is good for consumers: it fosters significant innovation, market growth and declining prices in very competitive markets**
- **Regulated IPR rates or undermining patent protection would be a tourniquet to innovation incentives**
- **Patent pools should be voluntary and subject to various other antitrust/competition safeguards**
- **FRAND violations are commercial disputes that courts can resolve when parties cannot agree**
- **The system is working: there is vibrant innovation in ICT with Standard Essential Patents and other IPRs**

# Thank You

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WiseHarbor helps its clients solve commercial problems with market analysis.

Keith Mallinson is a regular columnist with IP Finance (http://ipfinance.blogspot.com) "where money issues meet IP rights". This weblog looks at financial issues for intellectual property rights: securitization and collateral, IP valuation for acquisition and balance sheet purposes, tax and R&D breaks, film and product finance, calculating quantum of damages. Keith Mallinson writes on the subject of intellectual property in standardised technologies such as those used in 2G, 3G and 4G mobile communications.

**Sept. 3, 2012** | There Aren't Too Many Patents
**May 16, 2012**|The Folly of Picking Winners in ICT
**Mar. 29, 2012**| Patent trolls aren't all they are cracked up to be
**Feb. 3, 2012** ICT Esperanto and competition among standards
**Nov. 14, 2011** Scaremongers Falsely Claim IP Rights Impede Adoption of Standardised ICT and Public Policy
**Nov. 8, 2011** Valuing IP in Smartphones and LTE: Introduction by Jeremy Phillips including link to article
Valuing IP in Smartphones and LTE: Full article by Keith Mallinson (PDF)
**Sept. 20, 2011** Software Patents: a Convenient Misnomer for those who Seek to Expropriate IP
**Sept. 2, 2011** Artificial Distinction between Software and Telecoms for Essential IP Disclosure
**July 21, 2011** A Great Deal for Consumers in IP
**July 5, 2011** Fixing IP Prices with Royalty Rate Caps and Patent Pools
**June 12, 2011** Patent Licensing Fees Modest in Total Cost of Ownership for Cellular
**May 31, 2011** (F)RAND works -- If it ain't broke, don't fix it
**May 11, 2011** Fruits of Labour not Windfall Gains in Standardization