Squeezing Moore Wireless!
The Future of Wireless in Three Short Chapters

22nd Annual Institute
On
Telecommunications
Policy and Regulations

December 2, 2004

Squeezing Moore Wireless!

Chapter 1: What has worked (Spectrum Policy)!

- ***The FCC Approach to Licensed Wireless Services***
- ***A Successful Spectrum Policy Model and Necessary Preconditions***
- ***Other Upcoming Policy Challenges***

Chapter 2: Technology and its Implications for Spectrum Policy

- ***Creating Extra Communications Capability out of Existing Radio Licenses***
- ***Thoughts on Spectrum Policy Implications for Redistribution of Efficiency Gains from the Proactive Design Model***

Chapter 3: Marketplace Implications

Chapter 1: What Has Worked!

FCC's Spectrum "Management" Goals

TRANSPARENCY → EFFICIENCY → RELIABILITY

- **Promote the** highest and best use of spectrum **domestically and internationally in order to encourage the growth and rapid deployment of** innovative **and** efficient **wireless communications technologies and services.**
- **Advance** spectrum reform **by developing and implementing** market-oriented **allocation and assignment policies.**
- **Vigorously protect against** harmful interference **and enforce public safety-related rules.**
- **Conduct** effective and timely licensing activities **that encourage efficient use of the spectrum.**
- **Provide** adequate spectrum **for public safety and commercial purposes, including rural areas.**

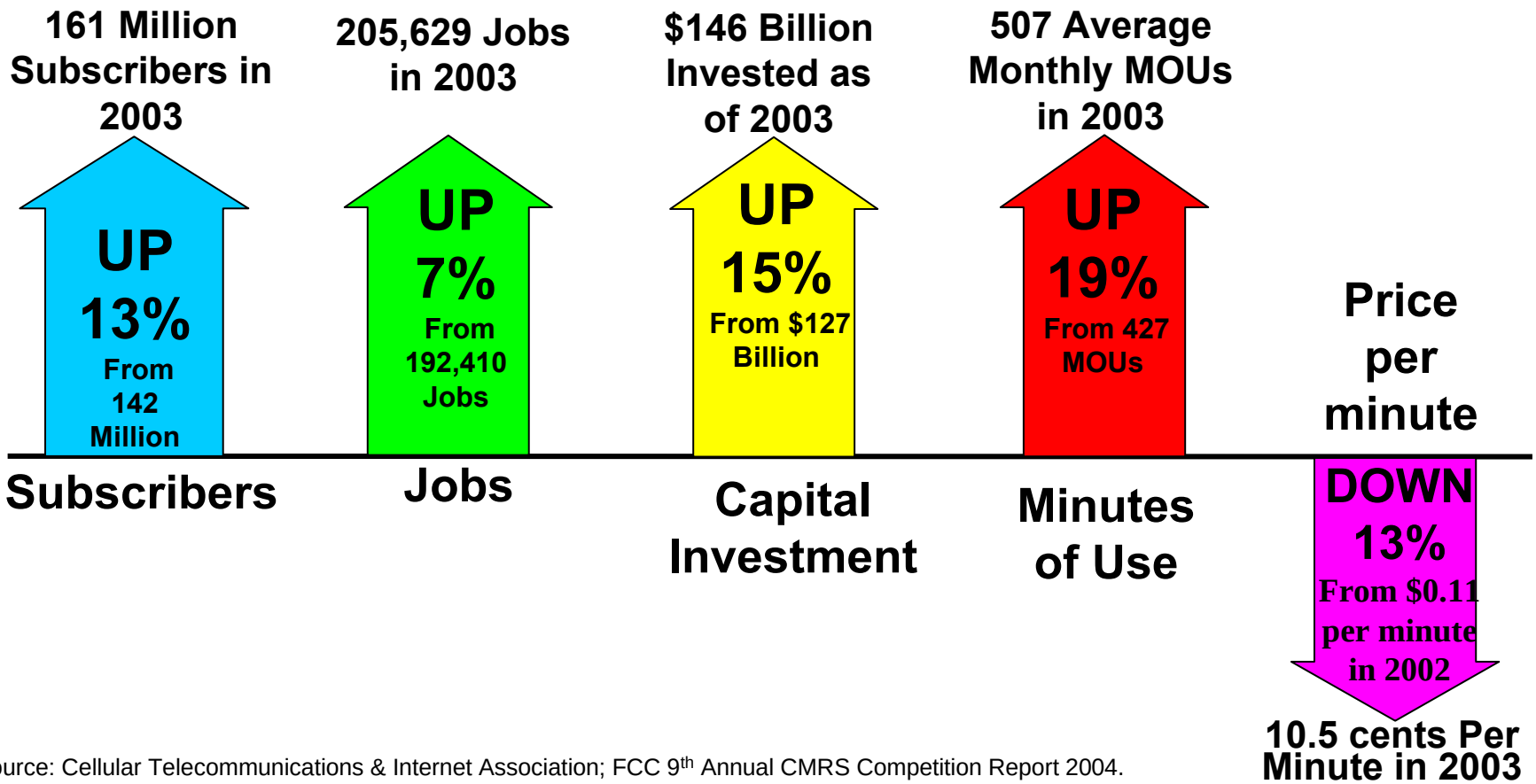
Formula for Successful Spectrum Management
The Flexibility Paradigm

- **Provide Flexibility** (provides for efficient use)
  - Maximum technical and operational autonomy for licensees
  - Rapid transition of spectrum to highest and best uses using market forces as much as possible

- **Ensure Competition** (provides for effective use)
  - Intermodal/Intramodal competition/Mass Media competition
  - LNP, intercarrier compensation, universal service, public interest
  - CMRS, PCS, MSS/ATC, MVDDS, DBS versus local, long distance, radio, television, movies, ISPs

- **Enforce Opportunity Costs of Using Spectrum** (provides market and economic discipline)
  - Auctions
  - Secondary Markets

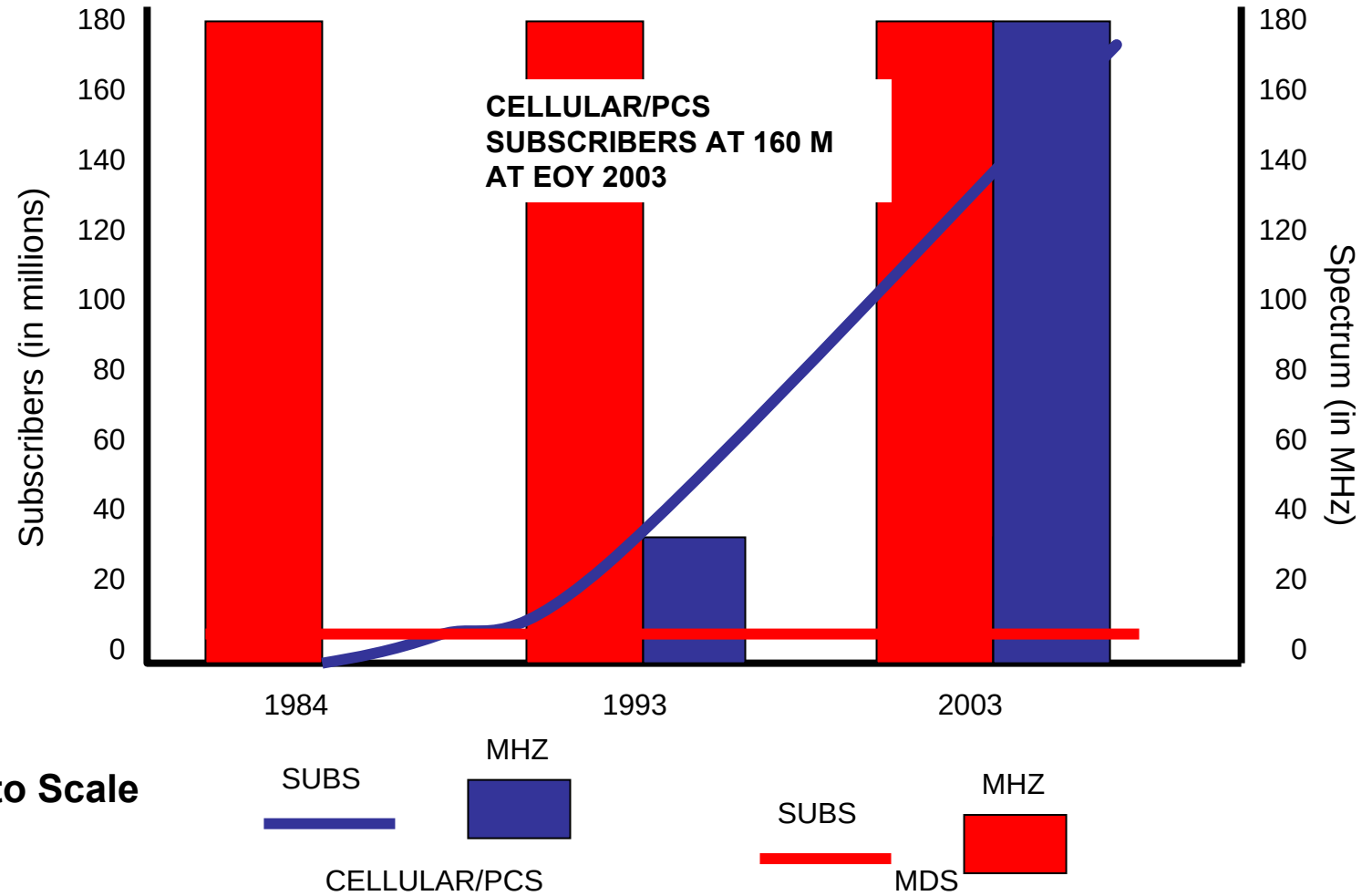
Spectrum "Management" Success Story Cellular/PCS (1993-2004)



Source: Cellular Telecommunications & Internet Association; FCC 9th Annual CMRS Competition Report 2004.

Squeezing Moore Wireless!

AN ILLUSTRATIVE EXAMPLE OF HOW FLEXIBLE REGULATIONS IMPACT MARKET ADOPTION RATES **



**** Not to Scale**

Licensed Spectrum & the Flexibility Paradigm

- **BRS/EBS Band (2.5-2.69 GHz)**
  - Flexibility (√)
  - Competition (?)
  - Opportunity Cost (?)
- **70/80/90 GHz**
  - Flexibility (√)
  - Competition (?)
  - Opportunity Cost (?)
- **700 MHz CMRS**
  - Flexibility (√)
  - Competition (√)
  - Opportunity Cost (√)
- **CMRS (Cellular, PCS, ESMR SMR)**
  - Flexibility (√)
  - Competition (√)
  - Opportunity Cost (√)
- **3G/AWS**
  - Flexibility (√)
  - Competition (√)
  - Opportunity Cost (√)
- **3650 MHz**
  - Flexibility (√)
  - Competition (?)
  - Opportunity Cost (?)

Other Upcoming Policy Challenges for Wireless

- **More attempts at State Regulation of Wireless challenging the détente largely in place since 1994; it is important to understand the reasons why this is happening**
  - Bad customer service and poor understanding of fundamentals of radio combine to create the perceived need to over regulate
  - Big Subscriber base makes it attractive to tax in one form or another

- **Outdated and Inefficient Intercarrier Compensation can slow down wireless development**
  - Most minutes are going wireless so wireline industry has an incentive to slow the migration or find a new revenue model;
  - The new ICC Policy regime, whatever it is, should be based on platform and technology neutrality principles

Other Upcoming Policy Challenges for Wireless

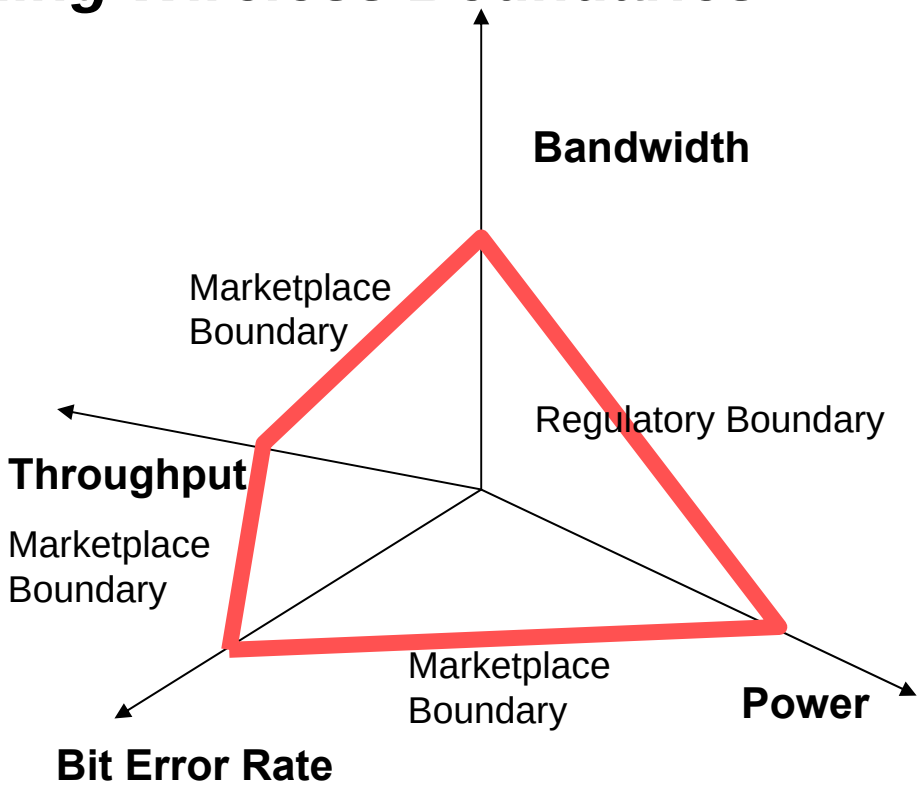
- **Enhancing of Wireless Coverage (in-building)**
  - Balancing real property rights and zoning against the broader consumer and public safety interest in having wireless services wherever consumers live, play, shop and work
- **E911 Phase 2 becomes a reality with attendant consequences**
  - accuracy, availability and new Location Based Services that impact issues such as privacy in ways we have never considered
- **The provisioning of public safety wireless services is a broken model under the new threat matrix and we need to rethink the overall approach….**
  - Rapid deployment
  - Nationwide availability
  - Interoperability is not just at the spectrum level but at the Information Services Layers

Chapter 2: Technology Impact On Spectrum and Spectrum Policy

Squeezing Moore Wireless!

Technology is Expanding Wireless Boundaries

- **Spectrum is not tangible; it is a set of constraints on how to operate using the electro-magnetic radiation.**
- **The FCC only controls two of the four constraint quadrants; that of power and bandwidth.**
- **The marketplace defines the rest by determining the required throughput and the required bit error rate.**
- **New technology allows all four quadrants to be in play at the same time and thereby creating new communications capability where it previously did not exist or was not economical.**



Squeezing Moore Wireless!

Spectrum Access is Enhanced with Availability of Miniaturized Dedicated Computing Resources for handling DSPs and Application Loads

- Chips dedicated for Digital Signal Processing (DSP) provides flexibility so spectrum is not a scarce resource (*per se*)
  - Dedicated chipsets for DSP only (Intel)
  - Chipsets available for high order tasks and low order tasks (QCOMM)
- Wireless Applications and CPE become **plug and play**
- Wireless Applications become IP-centric and digital
- Wireless platforms will support all high use applications available on other platforms

Squeezing Moore Wireless!

There is a Profound Impact on Wireless System Design

- ***The customary design of Wireless Systems is hard wired with no slack capacity in the enabling devices….the future design is all about increasing slack in the system…***

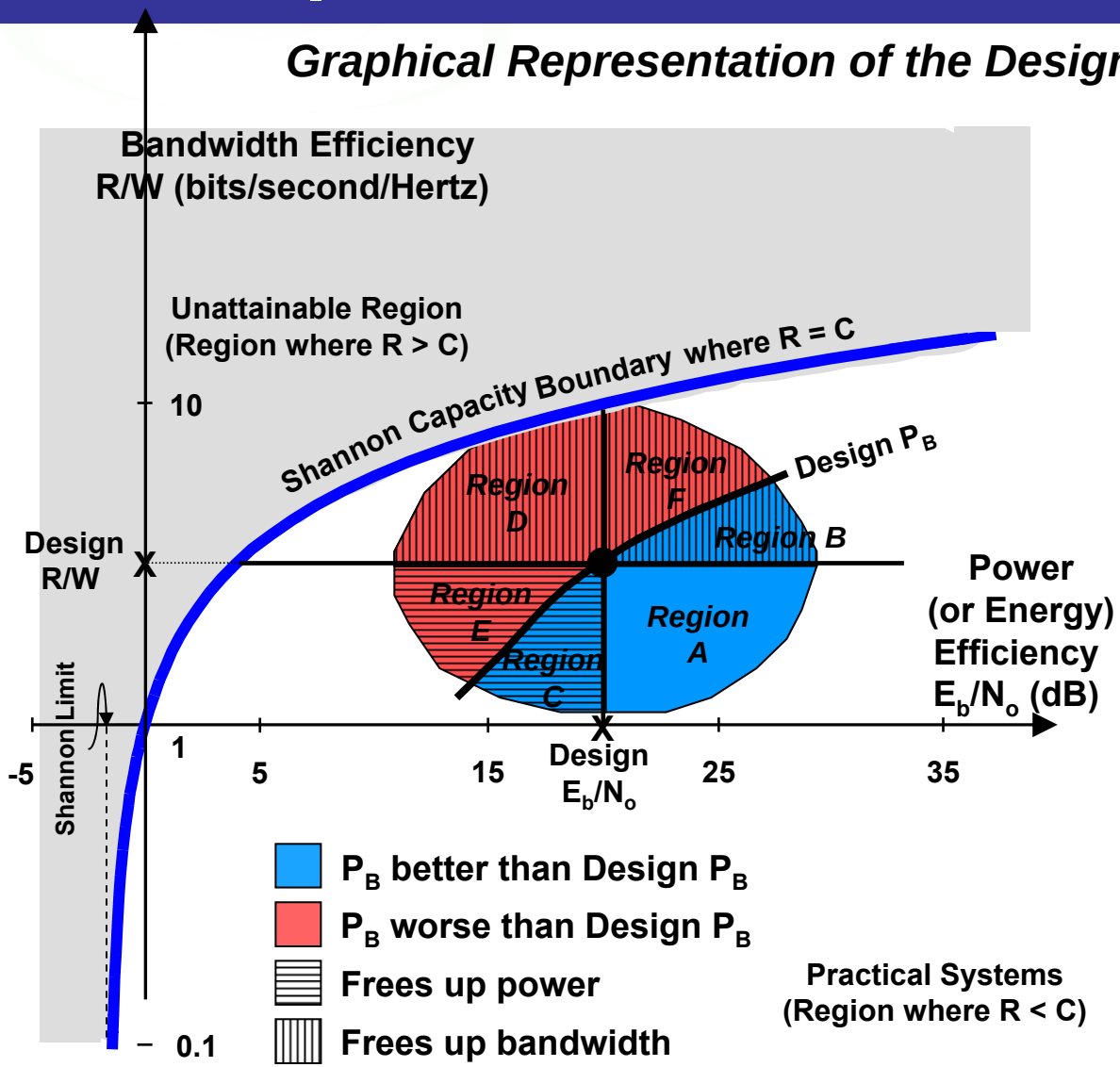
- ***In the new digital world Quality of Service ("QoS") trade-offs can take place dynamically because of the increased availability of computing resources…***

- *The future is to use software radios techniques to dynamically create where possible valuable extra communications capacity within existing licenses;* ***the design objective is to promote efficiency in Spectrum Utilization, while enabling licensees to offer competitive service in the marketplace***

- ***…and the Good News is that the FCC's Flexibility Policy Regime (discussed earlier) allows this type of design to take place…***

Squeezing Moore Wireless!

Graphical Representation of the Design Trade-Offs Now Possible



- Trade-offs in parameters define six regions about the design operating point.
- Region A: Achieves enhanced QoS, but would require more power and bandwidth, relative to optimized design. Presumably, both power and bandwidth are not available.
- Regions B & C: Achieves enhanced QoS and creates extra communications capabilities, if extra power or extra bandwidth is available:
  - Region B: Extra power frees up additional bandwidth,
  - Region C: Extra bandwidth frees up power or alternatively higher noise level tolerated.
- Regions D, E, & F: Resulting QoS is worse that Design QoS; but if lower QoS is commercially acceptable, ...

Technology's Challenge to Spectrum Policy

- The new designs now possible create more access to spectrum capacity and more intense use of spectrum where the Increased Spectrum Capability can be utilized for improving the existing service or developing new services.

- The FCC's flexible spectrum technology policies already encourage licensees to invest in expanded software radio designs to meet both a desired QoS and while achieving an increase in communications capacity, where possible.

- ***The new policy challenge is how to redistribute the resulting efficiency gains from this new design approach; should it be redistributed by fiat or by some type of marketplace mechanisms (e.g., secondary markets (leasing), private commons, two sided auctions, voluntary exchange mechanisms)***

Chapter 3: What are the Marketplace Implications?

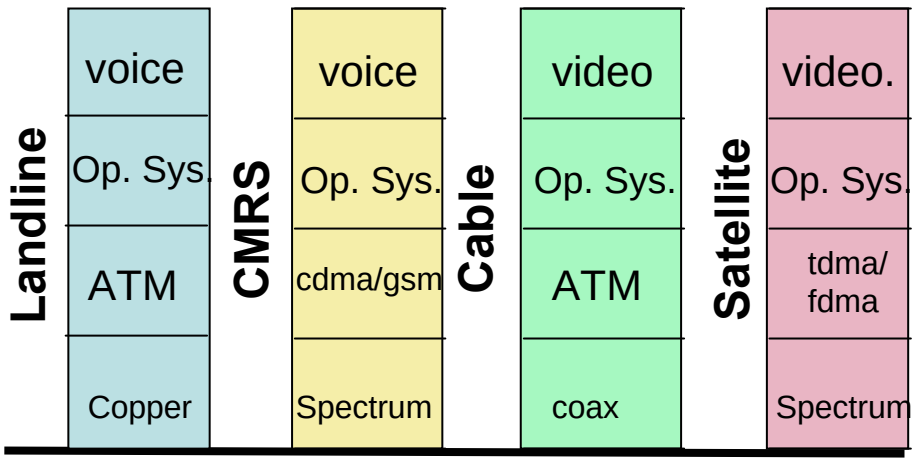
Squeezing Moore Wireless!

The Intermodal Fight is over "Wallet Share" and "Brand"

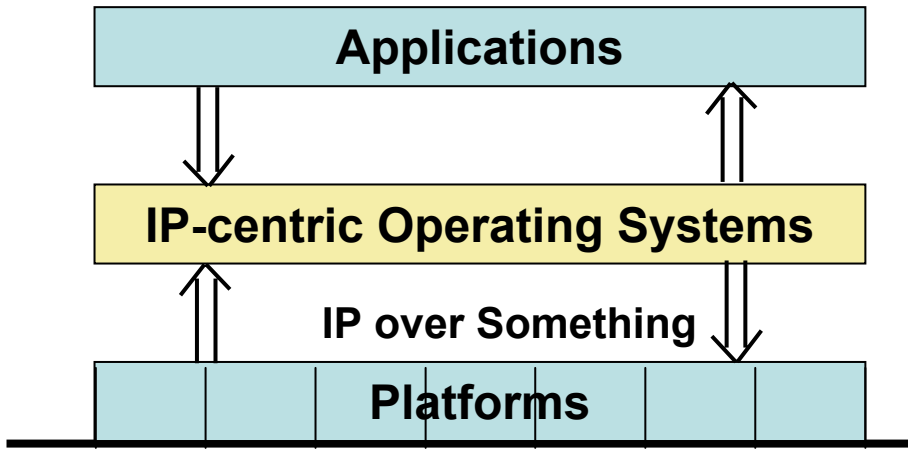
Wireless is Wheaties (consumer) business and all other modes are TOAST

Traditional Communications World

Inexorable Global Migration to Digital



SILOS



Layers

Wireless has won the battle for the Customer

- *Technology is rapidly expanding wireless capacity (more capacity in more places faster)*
  - ✓ *More spectrum to access*
  - ✓ *Cheaper to expand than cable, DSL, and Fiber (FTTH or FTTC)*
  - ✓ *More applications to carry*

- *High subscriber penetration changes fundamental telecom relationship with customers (I carry my cellphone not my cable modem)*
  - ✓ *Personalized service creates unique relationships and strong brands that lend to the wireless brand being more valuable*
  - ✓ *Global trend towards wireless having interoperable standards and convergence (unlike landline and cable) creating strong economic scale both in apps and equipment*

How can Wireless Keep Winning!

- *Invest in binding customers, not platforms*
  - ✓ *Focus on billing and customer service*
  - ✓ *Focus on creating and deploying binding applications that enhance personalization*
- *Invest in unique, scaleable applications*
- *Avoid OS traps on platforms (the binding problem again so focus on being IP enabled)*
- *Examples in the marketplace today*
  - ✓ *Simplicity (e.g., flat rate pricing)*
  - ✓ *Unified Intermodal GUIs (e.g.,"Vodafone LIve", Microsoft OS, Yahoo Broadband)*
  - ✓ *Interoperable features across wireless and other IP enabled platforms (e.g., interoperable Instant Messaging and SMS)*
  - ✓ *Personal information management services*
  - ✓ *Personalized mobile video services (e.g., QComms' MediaFlo, ESPN MVNO), personal safety applications (e.g., "U-Locate for teens")*