# The Evolution of Internet Infrastructures

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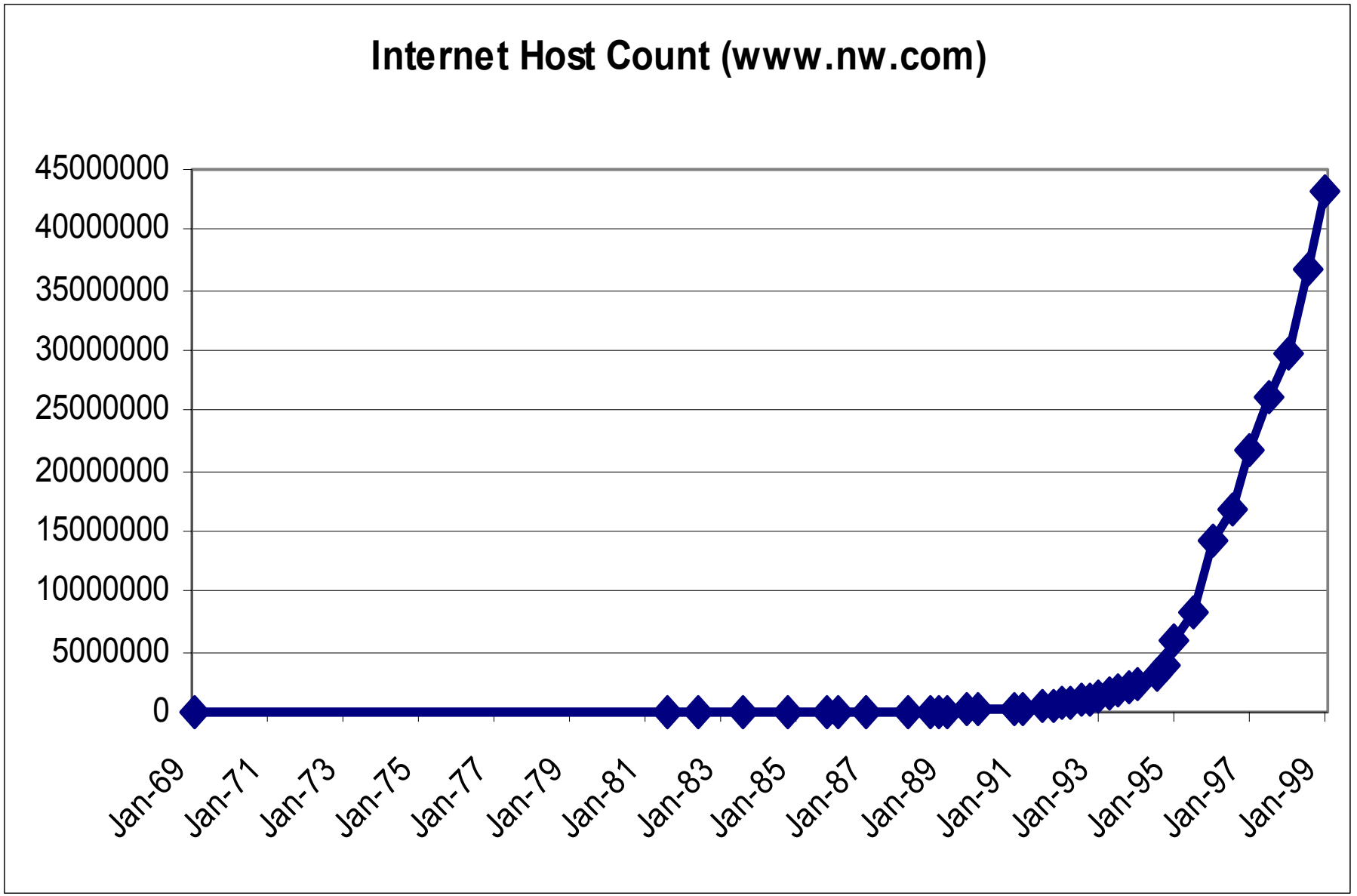
NTW Track 4


Internet Host Count (www.nw.com)
45000000
40000000
35000000
30000000
25000000
20000000
15000000
10000000
5000000
0
Jan-69
Jan-71
Jan-73
Jan-75
Jan-77
Jan-79
Jan-81
Jan-83
Jan-85
Jan-87
Jan-89
Jan-91
Jan-93
Jan-95
Jan-97
Jan-99

# Introduction

In general the Internet has followed similar evolutionary steps in every country where it has been introduced.

In some countries these steps have happened in very quick succession, in others there are discrete intervals of some years across each step.

# Introduction

Each phase does entail increasingly sophisticated infrastructure within the country concerned.

These steps are meshed with the development of the national communications infrastructure as much as they are concerned with the evolution of the Internet infrastructure.

# Introduction

Your mileage will vary!

# Phase 1

- the enthusiasts - anything that can be made to work ...

Cheaply !

# Phase 1

- Dial-based store forward email
- layered above modem  use of PSTN
- university and research  base - computing departments
- Messaging services interfacing to the Internet
  - UUCP
  - dial-IP
  - FRedMail

# Phase 1 - the enthusiasts

- Equipment
  - PC platforms
  - Linux, FreeBSD & Windows NT
  - modems
- Local Networks
  - small scale Ethernet LANs
- Service Platform - PSTN services
  - Dial
  - Limited X.25 packet switched services

# Phase 1 - the issues

- Issues:
  - Poor funding (if any!)
  - Intermittent services
  - specialised knowledge and high enthusiasm required to operate services
  - distributed expertise with no common management framework
- Cannot scale easily beyond hundreds or low thousands of users within a cell

# Phase 2 - the Grand Experiment

- Emerging commitment to Internet access
- National Academic and Research Internet Service

# Phase 2 - the Grand Experiment

- Academic and Research project
  - university based
  - government funding support
  - non-commercial
  - national agenda
  - no visible telco interest

# Phase 2 - A & R net

- Equipment
  - Unix workstations
  - PCs (Linux, FreeBSD & Windows NT)
  - Routers
- Local Networks
  - Campus LANs with switched backbone

# Phase 2 - A & R net

- Communications Service Platform
  - varied
    - Digital Data transmission services
    - PSTN - dial edges
    - X.25
    - private microwave and radio where feasible

# Phase 2 - A & R net

- national academic and research facility
- government financial support
- Imposed "Appropriate Use" guidelines
- funding by consensus guidelines within A & R
- strong content emphasis
  - library funding a strong driver in this phase
- often provide core services to dial-based message services

# Phase 2 - the issues

- Scaling pressures increase
  - pressure to service A & R fringes
    - governmental bodies
    - schools
    - commercial entities working in areas common with A & R sector

# Phase 2 - the issues

- fixed funding and strong dynamic growth
  - network outgrows its available funding base
  - pressures to commercialise to cross subsidise A & R networking growth

# Phase 3 - the Rush to Riches

- Emerging commercial interests for commercial access to the Internet
  - Dial-up market
  - leased line connectivity market

# Phase 3 - Commercial Internet

- Equipment
  - Service Provider
    - server platforms
    - modem banks and access servers

# Phase 3 - Commercial Internet

- Cmmunications Service Platform
  - reduced variety and increased robustness
  - PSTN
  - ISDN
  - Digital Transmission Systems

# Phase 3 - Commercial Internet

- multiple commercial providers
  - low entry cost and high perceived growth
  - outflow of skill set from A & R sector
- pressure to resell academic and research services
  - reduce A & R funding demands by selling at higher margin to commercial clients
- construction of distinct networks
  - issues of control over the platform
  - service market perceptions

# Phase 3 - the issues

- tariff structures
- Appropriate Use Policies and Interconnects
- regional vs national vs international operators
- Telco service platform issues
- Small scale enterprise
- cash flow small scale business models

# Phase 4 - Business Pressures

- The Internet as a business
  - Residential dial
  - Commercial marketplace
  - commodity market in access services
  - emerging content and trading markets
- Investment pressures
- Stock floatations
- Regulatory changes

# Phase 4 - the issues

- The demise of the Academic and Research Network
- tariff structures move to marketing dictated structures
- Interconnects and peering structures
  - outcome of interaction of a small number of large providers and a large number of small providers

# Phase 4 - the issues

- telco involvement now visible
- pressure on market from large investment base
  - threatened industry bases move into the Internet to secure any form of future
- marketing pressures become more aggressive
- steady stream of new entrants

# Phase 4 - the issues

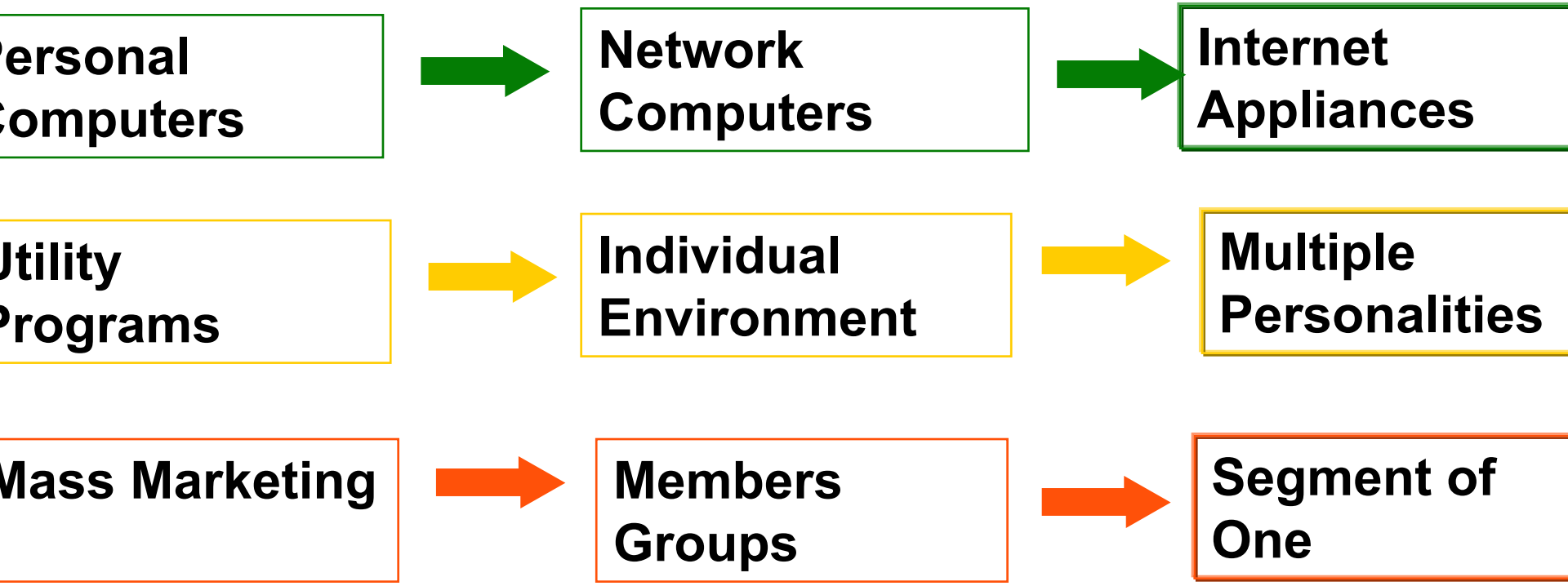
- marginalisation or expansion of existing commercial players as investment pressures are bought to bear

# Phase 5

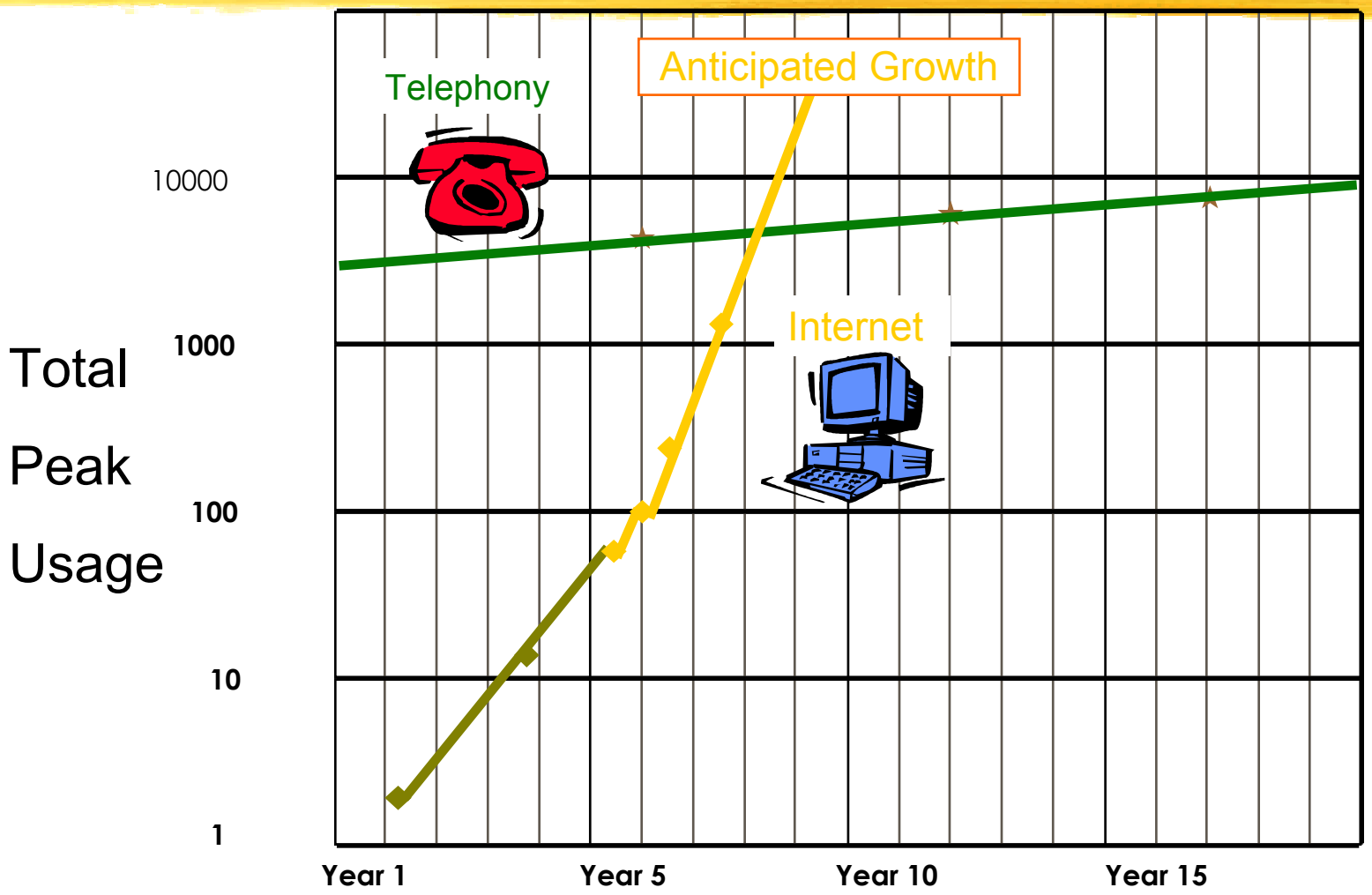
- no country is there yet …

But

# Phase 5


ersonal
omputers
Network
Computers
Internet
Appliances
tility
rograms
Individual
Environment
Multiple
Personalities
Mass Marketing
Members
Groups
Segment of
One

# Phase 5


Telephony
Anticipated Growth
Internet
10000
1000
100
10
1
Total
Peak
Usage
Year 1
Year 5
Year 10
Year 15

# Phase 5 - what's next?

- Will the Internet drive out the phone business?
  - Can a telco survive a phone crash?
- Can the diverse access market survive the telco investment pressure and telco inertia?
- Will national infrastructure fall prey to:
  - international cable cartels ?
  - LEO systems ?
  - Internet incursions ?

# Phase 5 - what's next ?

- globalisation and consolidation

or

- fragmentation and anarchy

# Today

- telco involvement now very visible !
- massive growth pressure on the Internet from a very large investment base
  - threatened activity bases move into the Internet
  - new electronic markets opened
  - new communications market opened

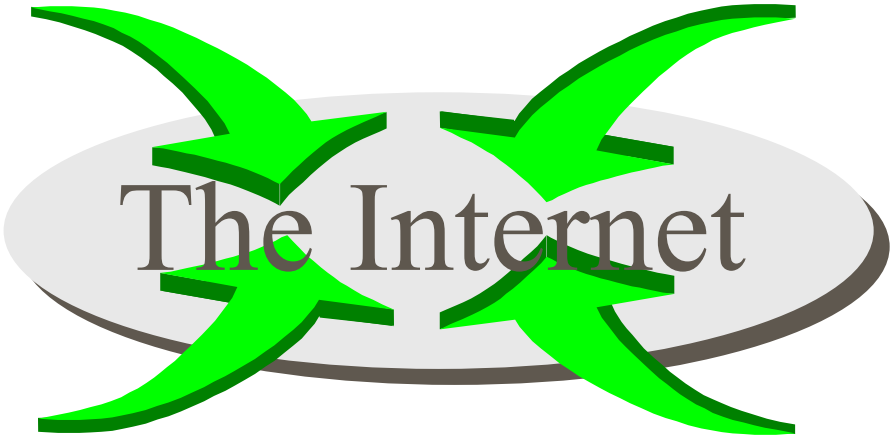
# Today

- A potentially revolutionary communications model
- BUT
  - anarchic administrative structure
  - rapid growth fatigue
  - stressed infrastructure
  - no coherent utility model

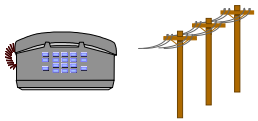
# Today's Environment

Information Tool

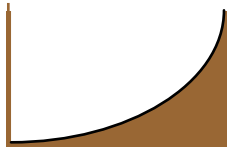
Free Market




Public Communications Utility



Growth



# Current Issues

- Deregulated Service Provider market
  - low entry price as an ISP
  - very active market
  - high variability in pricing and quality
  - poor levels of consumer awareness
  - high volatility in the marketplace
  - in general poorly financially resourced

  - Increased regulatory structure initiated through consumer protection initiatives ?

# Current Issues

- Backbone "wholesaler" and Access "retailer" model
  - will change as..
    - backbone providers enter the retail market
    - retailers band together to defend existing market share
    - new technologies impact on PSTN dial access model
  - Niche retail markets, opened through rapid market expansion, close as the expansion pace slakens off ?

# Current Issues

- Market demand exceeds capability of supply
  - poor performance levels due to saturation of existing capacity
  - change of growth patterns for communications
  - existing supply systems are indicating signs of stress!

  - Market demand will continue to outpace supply rates for the next 3 - 5 years at least

# Current Issues

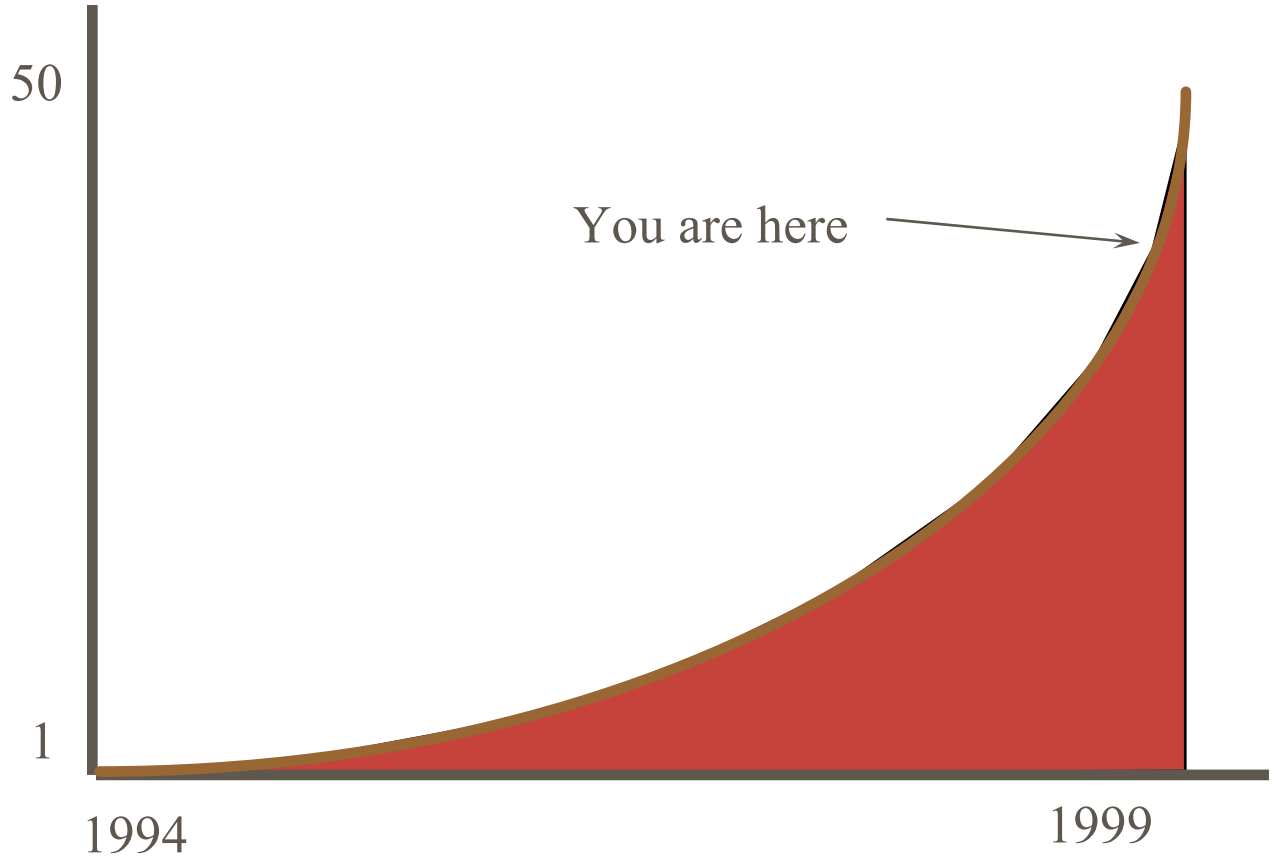
- Content and Advertising
  - Is there a pay per view market?
  - Is there a advertising market which can survive "fast forward" ?
  - Will spamming jam email to the extent that public directories are withdrawn?
  - Is there any moderating factor on behaviour?
  - Advertising models will evolve - the current match of the model to the medium is too poor to be effective

# Current Issues

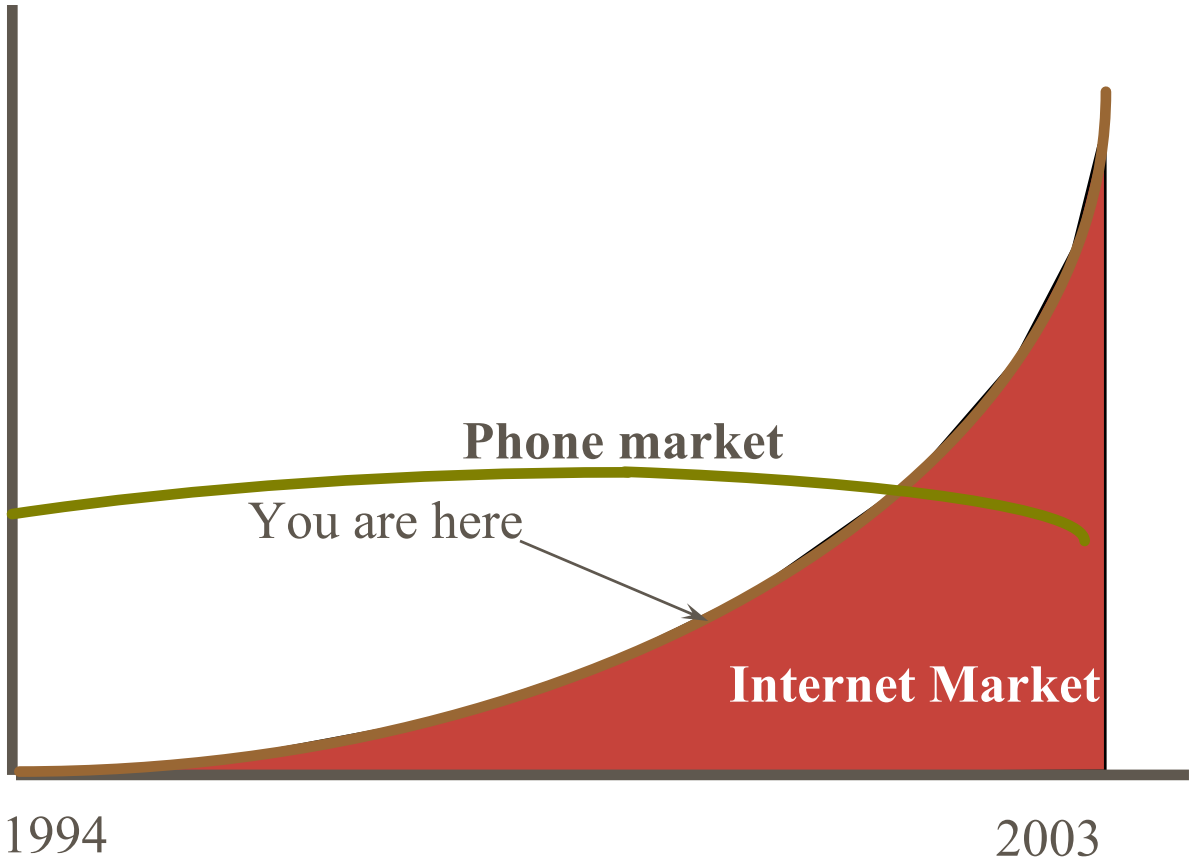
- Electronic commerce
  - where's the transaction?
  - Where's the bank?
  - Where's my money?
  - Who pays the tax?
- Will the market grow faster than the regulators can regulate to save the current system?

# Futures

- Linear thinking in an Exponential World



# Internet Futures



# Near Term Futures

- marginalisation or expansion of existing commercial players as investment pressures are bought to bear
  - expansion rates open niche markets
  - these markets close down when growth rates stabilise, due to competitive price pressures

- Currently there are 35,000 Internet Service Providers in the world
  - this number will eventually decrease

# Futures - Internet / Telco

- Will the Internet drive out the telco voice business?
  - Voice over the Internet is technically feasible
  - Is widespread deployment a likely outcome?
  - Will service quality be a determinant factor?
  - How will existing phone players survive if the squeeze happens?
- This outcome is unlikely in the next 5 - 10 years. Longer term predictions are highly speculative!

# Futures - Internet / Telco

- Can the Internet market survive the telco?
  - investment pressures
  - economies of scale
  - protection of value of existing assets
  - current asset holdings of communications infrastructure
  - historically regulatory position of the Telco

# Futures - Technology

- Is there a single "killer application" for the Internet?
  - nope!
  - The Internet is FAR more versatile than that!
- Embedding communications and processing
  - the "Internet chip" as a base of new consumer products
- Internet market expansion based on expansion of consumer products which use digital communications

# Futures - Technology

- Can the Internet survive massive consumerism in technology terms?
  - fragmentation in address space
  - fragmentation in name space
  - scaling pressures in the routing space surpass available silicon
  - channel capacity pressures surpass available infrastructure
  - no service quality structure
  - fragmentation in connectivity space

# Futures - Technology

- What will it look like?
  - Boxes, Screens, Keyboards and Mice
  - Digital Assistants
  - Network Computers
  - Personal Communicators
  - Not just smart, but highly communicative plastic money cards
  - really well connected and well informed coffee makers

# Futures - The Information Economy

- workforce requirements
  - information literate
  - flexible
  - skill specialisation

# Futures - The Information Economy

- effective domestic communications infrastructure
  - restructuring may be necessary to achieve maximal potential from the existing infrastructure investment
  - strategically separate the provision of basic bit carriage from layered services of voice and data switching
  - Mix of public and private investment profiles may be necedssary to achieve effective infrastructure platform

# Futures - The Information Economy

- Will national infrastructure fall prey to international comms consortia?
- Is this a politically tenable / stable outcome?

# Futures - The Information Economy

- effective international communications infrastructure
  - undersea cable systems under stress due to Internet expansion
  - rapid expansion of cable rollout plans
  - potential restructuring of international communications agreements

# Futures - Social

- The Internet will drive a process of social change
  - alter the basis of economic wealth
  - alter the flows of information within society
  - Change the operational model of social structures
- It is unrealistic to anticipate a smooth transition...