Won't get .fooled again
One outlook for 2004 and beyond

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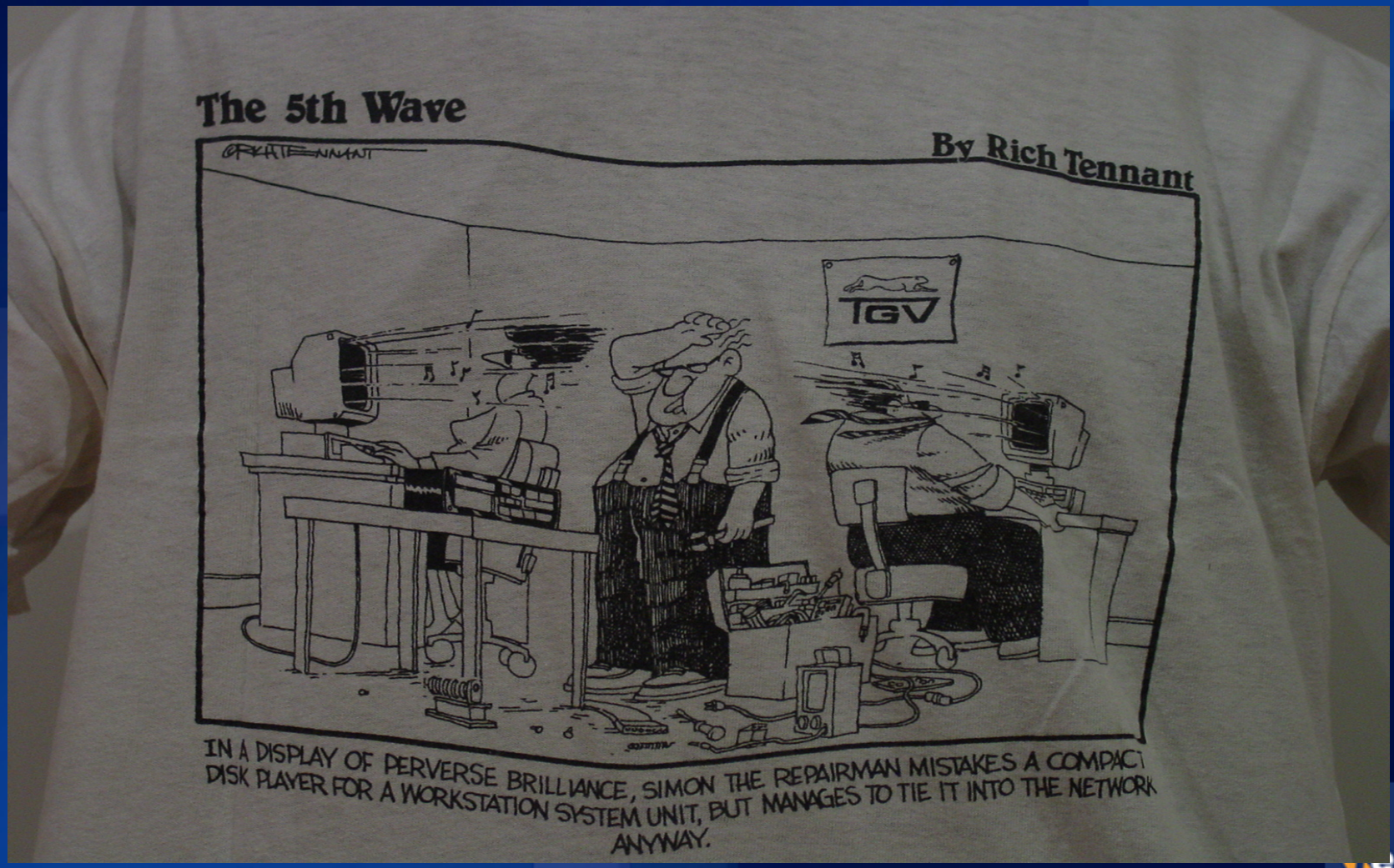
Boom and Bust…

- Is nothing new…
  - 1637 – tulip mania takes hold and the price of tulip bulbs escalates to fantastic levels
  - 1719 Banque Royale – John Law introduces the French crown to the magical mysteries of bank credit and paper money. At this point the word "millionaire" entered our vocabulary. But by 1720 the Parisian crowd were less than impressed with Law's sharp dealings as the French economy collapsed utterly
  - 1847 – the great British Railway Boom and subsequent bust

Oh What A Boom!

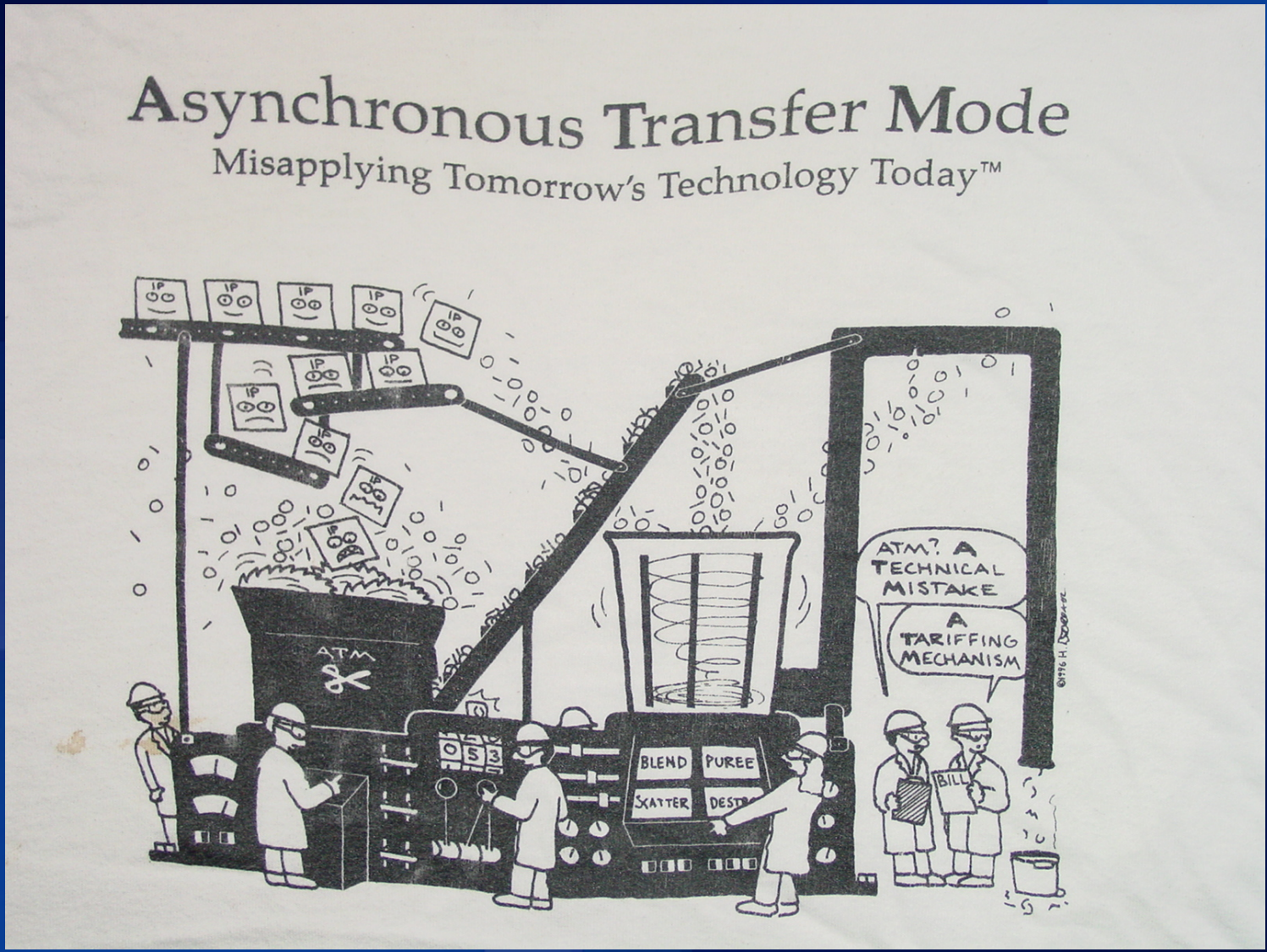
- There is no doubt that the Internet boom was as euphoric, as imaginative and as inspired as any other boom
  - Just remember the Tshirts……

Anything was possible

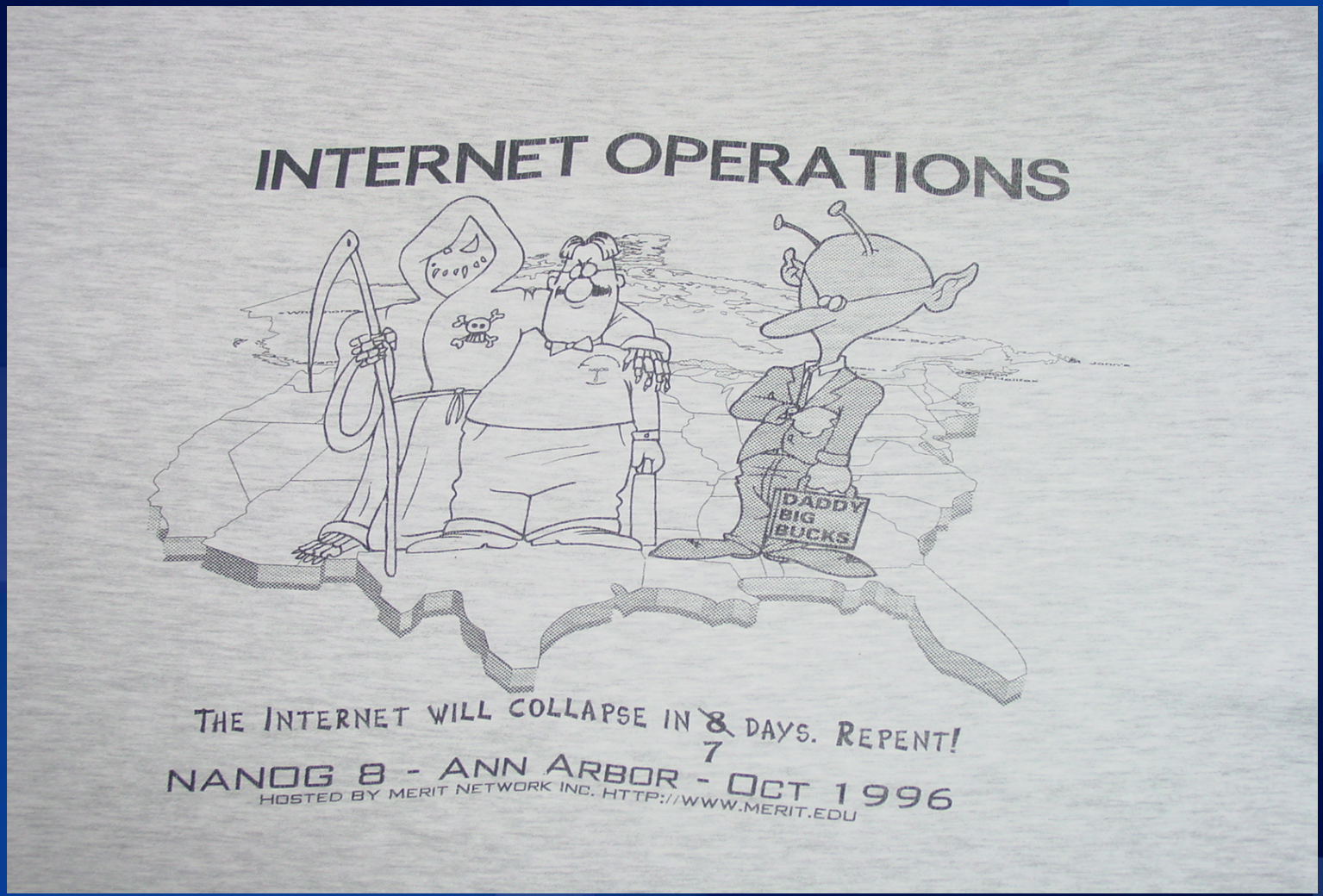


Even Internet Toasters

And the old ways of doing things were ridiculed

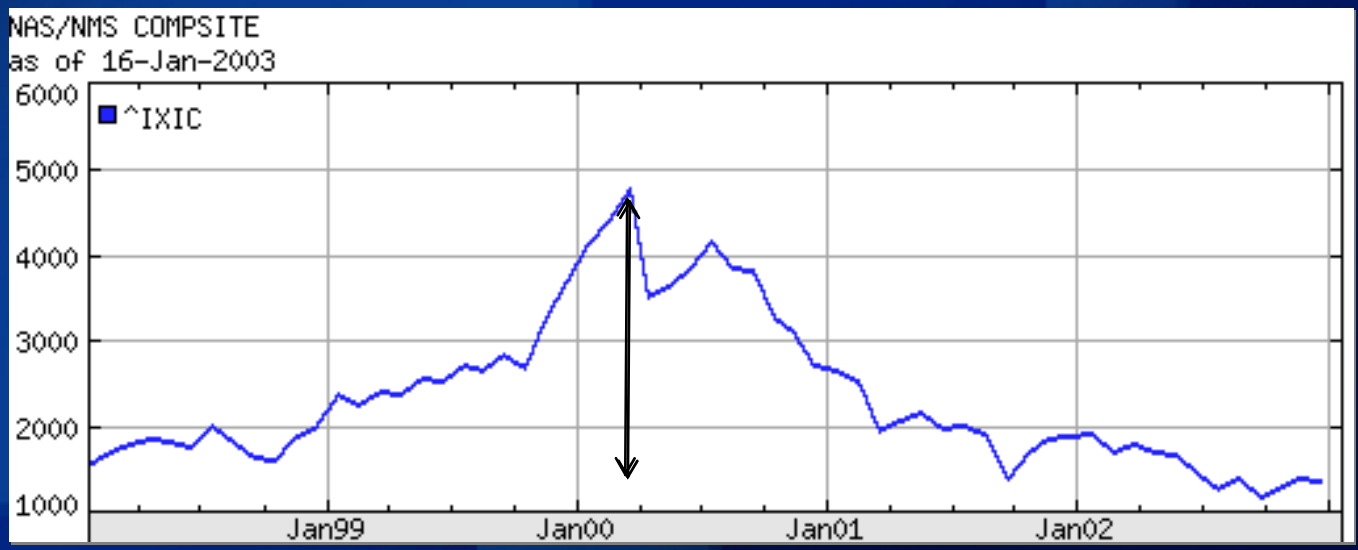


But the spectre of a bust was lurking just around the corner



It's a post-dot-boom-and-bust world

- The Internet boom has been pretty mild by comparison with booms in gold, oil, rail, shipping, ice and, of course, tulips.
  - The peak of the Internet boom saw stock indices peak at 4 - 5 times their longer-term value



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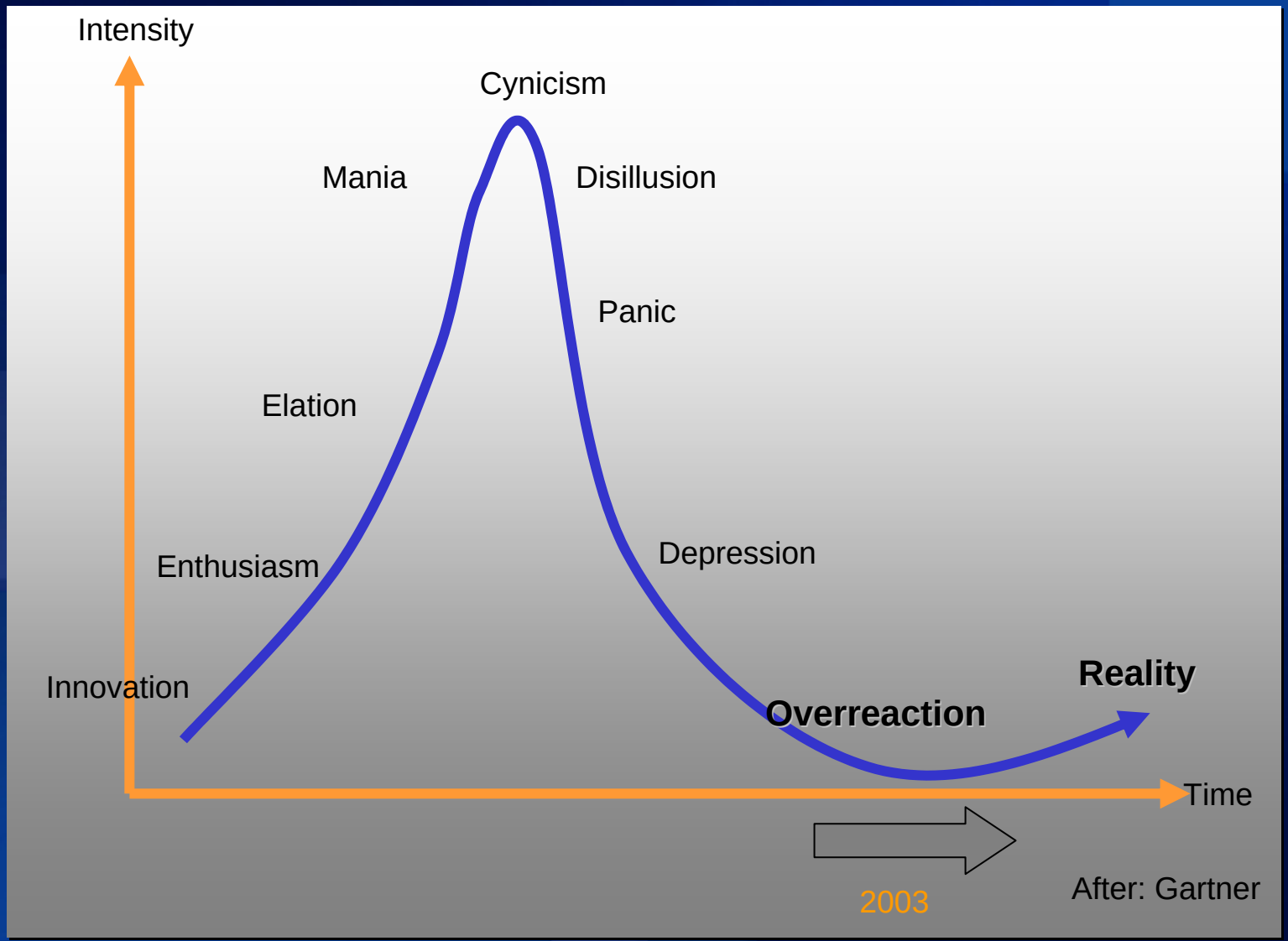

Today


NAS/NMS COMPSITE
as of 1-Aug-2003
^IXIC
5500
5000
4500
4000
3500
3000
2500
2000
1500
1000
Jan99
Jan00
Jan01
Jan02
Jan03

So…

- What have we learned from all this?

Today

- ISPs can no longer operate a rapid expansion-based business model
  - Current business models are tending to use a common theme of service consolidation
  - Market share is now an increasingly important metric
  - There is now a highly competitive market for Internet-based service provision

Today

- Attention is now concentrating on the basic aspects of the Internet service model:
  - Dependability and integrity
  - Utility
  - Price Competitiveness

- Relatively less focus on:
  - Value-add service models
  - Quality and Selective Performance Outcomes
  - Innovative applications and services

From Optimism to Conservatism

- We've learned once more that optimism alone is no substitute for knowledge and capability
- That business plans require more than an animated slide pack
- That the business of communications is not a recent one and not a small one – and it does not change overnight every night

From Optimism to Conservatism

- A conservative period of steady expansion rather than explosive growth
  - Investment programs need to show assured and competitively attractive financial returns across the life cycle of the program
  - Existing investments cannot be discarded at whim
  - Reduced investment risk implies reduced levels of innovation and experimentation in service models
  - Accompanied by greater emphasis on service robustness and reliability
  - Combinations of communication services with additional services to create value-added service bundles

Security Focus

- We've learned that we cannot operate global networks based on informal trust models

- Its likely that we will see a highly visible security focus for the next few years, due to:
  - Increased end-user awareness of vulnerabilities and weaknesses and a desire for more secure and trustable services
  - Increased public sector agency awareness of the vulnerabilities of the Internet communications environment and its consequences
  - A response based on increased technology effort in dismantling aspects of the Internet's distributed trust model and attempting to replace it with negotiated conditional trust
  - Expect encryption and authentication at many levels of the IP protocol suite

Security Issues

- We've learned that we need to understand more about what stakeholders want from the Internet in terms of security
- Many components of IP are not anywhere near secure enough:
  - DNS
  - Routing
  - Transport
  - Addressing
  - Data Plane / Control Plane distinction
  - Content
- Vulnerabilities are just about everywhere

Security Issues

- The list of outstanding issues include:
  - How can users identify each other?
  - How can users identify network-based services and validate the integrity of such services before entrusting them with data?
  - How can the network protect itself from abuse and attack?
  - How can users protect themselves from abuse and attack?
  - What are a user's obligations and responsibilities?
  - How can abusers be identified? And whose role is it?
  - What is the role of the ISP?
    - Neutral common carrier?
    - Trusted intermediary?
    - Enforcement point?
- Time to get working!

Convergence and Multiple Networks

- We've learned that IP is not the panacea of communications protocols

- Recognise IP's strengths and weaknesses
  - IP is not a network resource management architecture

  ☺ IP allows adaptable traffic sessions to operate extremely efficiently over wired networks

  😐 IP is not the optimal approach to support:
    - mobile wireless traffic
    - resource management requirements

  ☹ IP is not strong in supporting:
    - real time traffic under localized congestion events
    - various forms of traffic engineering applications

Convergence and Multiple Networks

- What's the desired model here?
  - Adaptive response networks supporting non-adpative application transport sessions

  Or

  - Best effort networks supporting cooperative adaptive transport sessions

- So far, the efforts in IP have obtained the greatest leverage through using adaptive applications through a common base best effort network. There are no real signs that this model is changing in the coming few years

Bandwidth Abundance

- We've learned that when you eliminate one choke point in a system you expose others

- Dense Wave Division Multiplexing is lifting per-strand optical capacity
  - from 2.5Gbps to 6.4Tbps (640 wavelengths, each of 10Gbps per lambda) per optical strand
- The major long haul communications routes worldwide are more than amply provisioned with IP bandwidth
  - The shift from demand-pull to supply-overhang is impacting the business stability of the long haul communications supply market.
- The network 'choke' points are shifting to the access domain, not the long haul elements

Broadband Last Mile

- An steady continuation of the shift to a pervasive broadband access model for IP
  - Gradual phase out of modems as the dominant IP access device
    - Here are many externalities that determine the speed of this trend
  - Industry concentration on deployment of fibre, coax and DSL based last mile networks
- Associated with this is the need to deploy higher speed last mile access switching systems
  - allow concentration and switching of user traffic across a shared last-mile high capacity access system

Technology – IPv4

- We're learning that we might be stuck with making IPv4 work for longer than we thought

- V4 remains the overwhelmingly dominant protocol choice for the Internet today
  - 32 bit (4G) address space
    - 46% allocated
    - 29% deployed
    - 5%- 10% utilization density achieved
    - Consumption at a rate of 32M addresses p.a.

Scaling the Network - The IPv4 View

- Use DHCP to undertake short term address recycling
- Use NATs to associate clients with temporary (32 + 16) bit aliases
- Use IP encapsulation to use the outer IP address for location and the inner IP address for identity
- And just add massive amounts of middleware
  - Use helper agents to support server-side initiated transactions behind NATS
  - Use application level gateways to drive applications across disparate network domains
  - Use walled gardens of functionality to isolate services to particular network sub-domains

Scaling the Network

- Or change the base protocol

Scaling the Network - The IPv6 View

- Extend the address space so as to be able to uniquely address every connected device at the IP level
- Remove the distinction between clients and servers
- Use an internal 64/64 bit split to contain location and identity address components
- Remove middleware and use clear end-to-end application design principles
- Provide a simple base to support complex service-peer networking services

Technology – IPv6

- Remember that silicon is a volume industry
- This is an issue for high volume deployments including:
  - GPRS mobile
  - Pocket IP devices
  - Consumer devices
- IPV6 appears to offer reasonable technology solutions that preserve IP integrity, reduce middleware dependencies and allow full end-to-end IP functionality for a device-rich world

Sony DCRTRV950

- Playback Zoom
- i.LINK (IEEE1394) IN / OUT
- Video IN / OUT
- S-Video IN / OUT
- Audio IN / OUT (Stereo)
- USB Terminal
- Intelligent Accessory Shoe
- Headphone Jack (Stereo)
- NPQM91: 370 min

Network Function

- Bluetooth Standard: Ver 1.1
- Email: SMTP, POP3
- Web Browser
- HTML: HTML3.2, Frame. JavaScript, SSL (V2/3)
- Image: GIF, JPEG, XBM, PNG

Technology and Architecture

- Both IPv4 and IPv6 use overloaded semantics for and address
  - Who (end-point identification)
  - Where (locator)
  - How (forwarding token)
- Are there benefits in using a split-approach?
  - E.g. end-to-end transport sessions using end identifiers, mapping a session to locators in packet headers
- Somehow, in the next few years, we need to encompass a world of prolific silicon with simple scaleable solutions

Wireless

- *In theory*
  - IP makes minimal assumptions about the nature of the transmission medium. IP over wireless works well.
- *In practice*
  - high speed TCP over wireless solutions only works in environments of low radius of coverage and high power
  - TCP performance is highly sensitive to packet loss and extended packet transmission latency
- 3G IP-based wireless deployments will not efficiently interoperate with the wired IP Internet without adaptive media gateways
  - Likely 3G deployment scenario of wireless gateway systems acting as transport-level bridges, allowing the wireless domain to use a modified TCP stack that should operate efficiently in a wireless environment
- 802.11 is different
  - And 802.11 is now well established

Voice over IP

- We're learning that voice has more dimensions than just emulating simple carriage of a voice signal

- The technology is getting better…
  - Load-sensitive codecs that adjust their signal rate to the current delay / loss characteristics
  - Abundant trunk bandwidth circumvents the need for detailed QoS in the network core
  - Solutions available to map between the telephone address domain and the Internet address domain (ENUM)
  - Intertwining hand-held devices into phone + PDA
- But many practical technology, regulatory and business issues remain on the VOIP path….

Services and Middleware

- We're learning that you can't completely separate various service platforms from the network
- WWW caching technologies is maturing with the addition of a more generic approach to include aspects of:
  - Interception technologies
  - Open pluggable edge service technologies
- Service provision and IP Anycast to create improved resiliency for critical infrastructure elements
- Directory technologies and mapping of disparate protocol and services domains into the IP world
- The shift in focus in identity domains from "how" to a persistent version of "what"
- Public Key Certificate structures to support integrity of referential operations
  - Are as needed now more than ever!

What have we learned?

- That the Internet is not infinitely elastic and some things just cannot fly no matter how much thrust is put behind it
- That social change often takes far longer than technology change
- That the Internet may not be the best entertainment medium today – but it's a remarkable exchange medium
- That an efficient, ubiquitous and communications infrastructure is a valuable national and global asset
- That building communications infrastructure is one thing, using it to best effect is another. Both aspects require care and attention.
- That this is a technology-intensive activity with much that we still have to learn

So what can we expect?

- My personal list of expectations for the next few years:
  - No repeat of boom and bust
  - Conservative business objectives with conservative returns
  - Continued levels of regulatory interest to ensure that public objectives are being achieved
  - Continued expansion of the underlying infrastructure
  - Industry sector members with longer term objectives phrased more modestly than may have been the case in the past five years
  - In other words.....

Meet the new economy.

Same as the old economy.

The classic The Who song, written by Pete Townshend, *Won't Get Fooled Again* was first recorded in early 1971. It was released as a single and on the *Who's Next* album in August 1971. This song formed the climax of their stage set.

This song is about the same age as the Internet.

Thank You