Costs and Benefits of Running a National ARD:

China's Footprint on the Internet Routing Table

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魏堂明

Tom Vest

Packet Clearing House*

APRICOT*

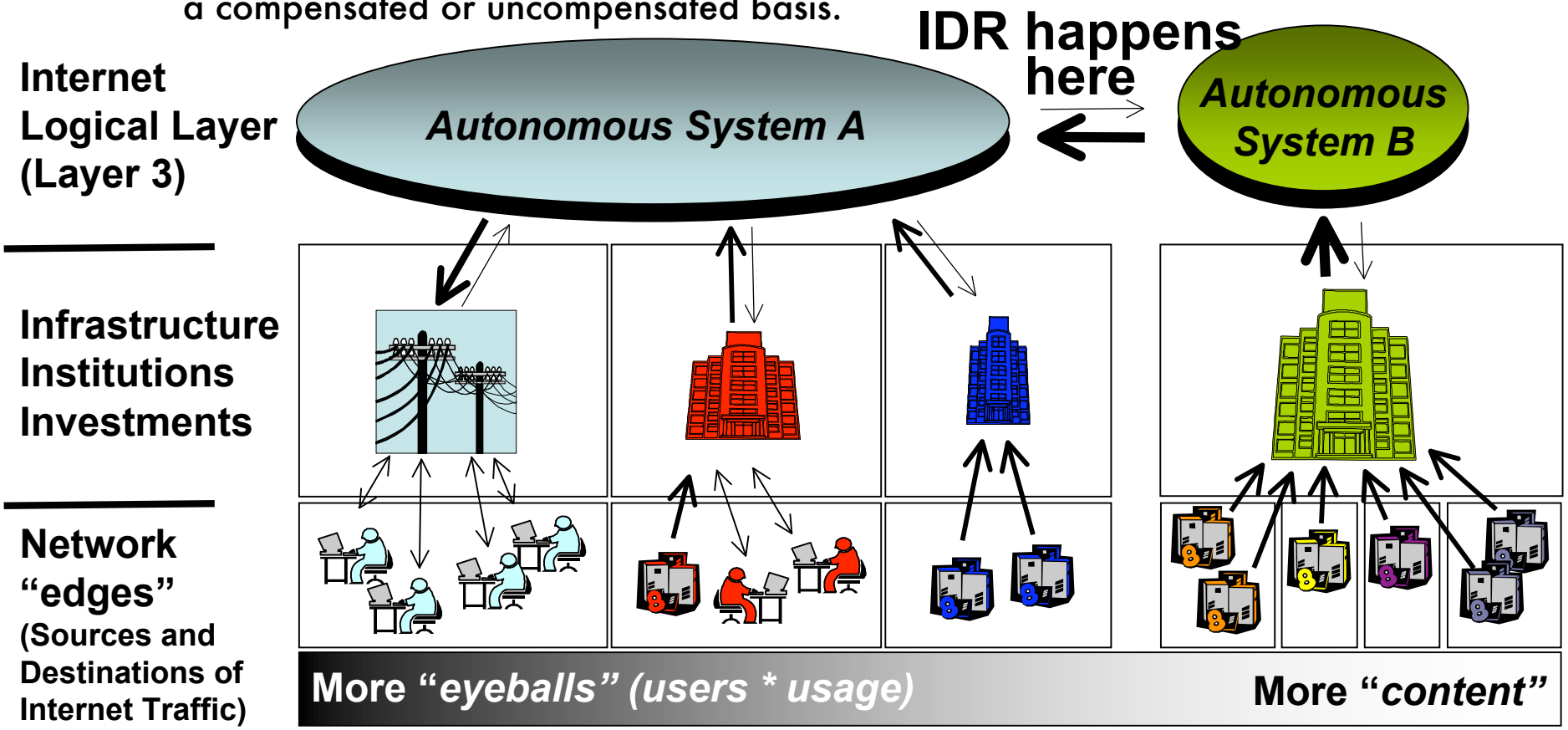
University of Southern California*

tvest@pch.net

**Views expressed are mine alone*

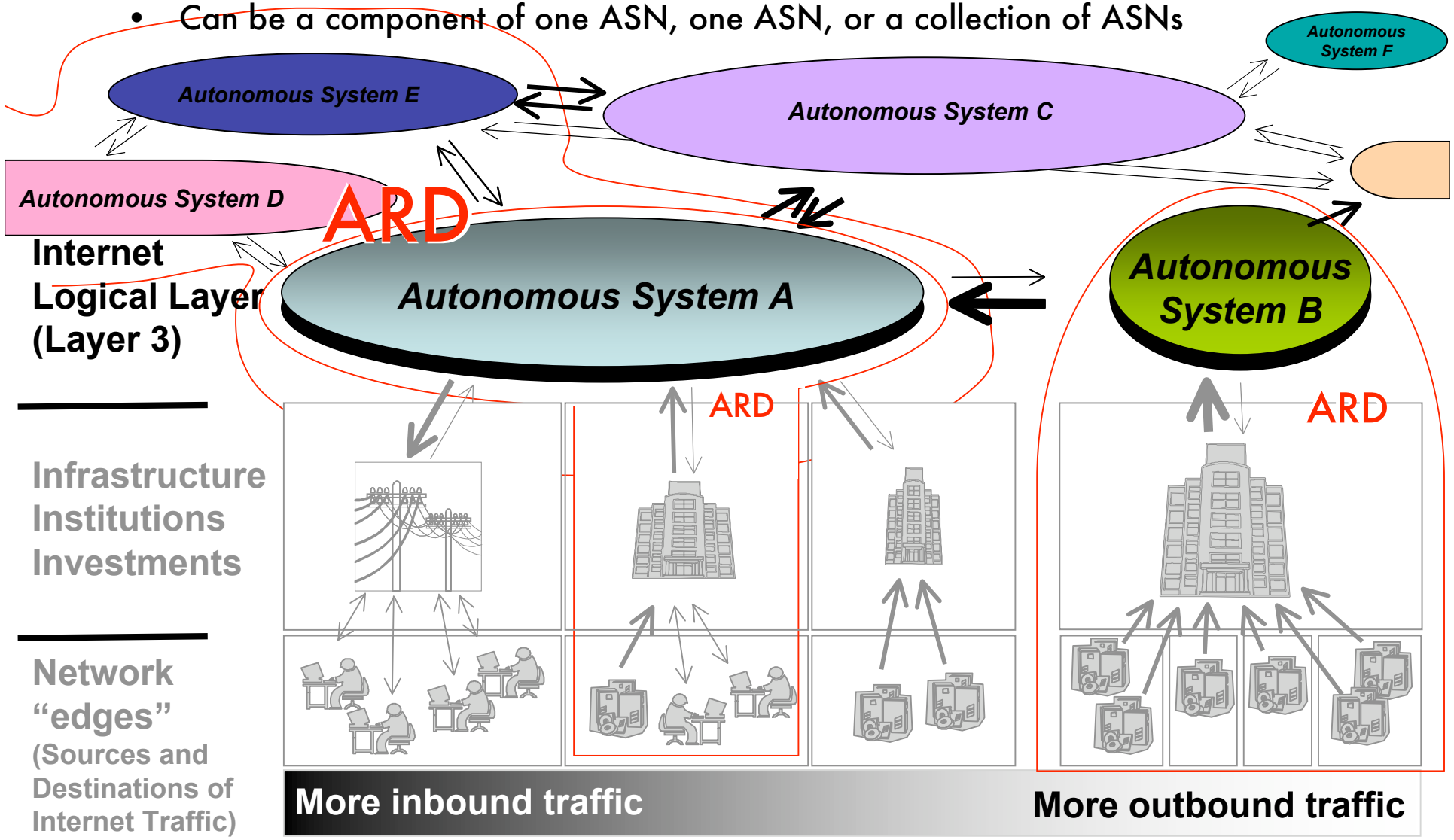
What is Inter-Domain Routing (IDR)?

- **In engineering terms**, the exchange of routing information and Internet traffic between administratively distinct Autonomous Systems, each of which is represented by a unique AS Number (ASN).
- **In economic terms**, the mechanism whereby the value of investments in infrastructure and service development is exchanged between networks on a compensated or uncompensated basis.



What is an Autonomous Routing Domain (ARD)?

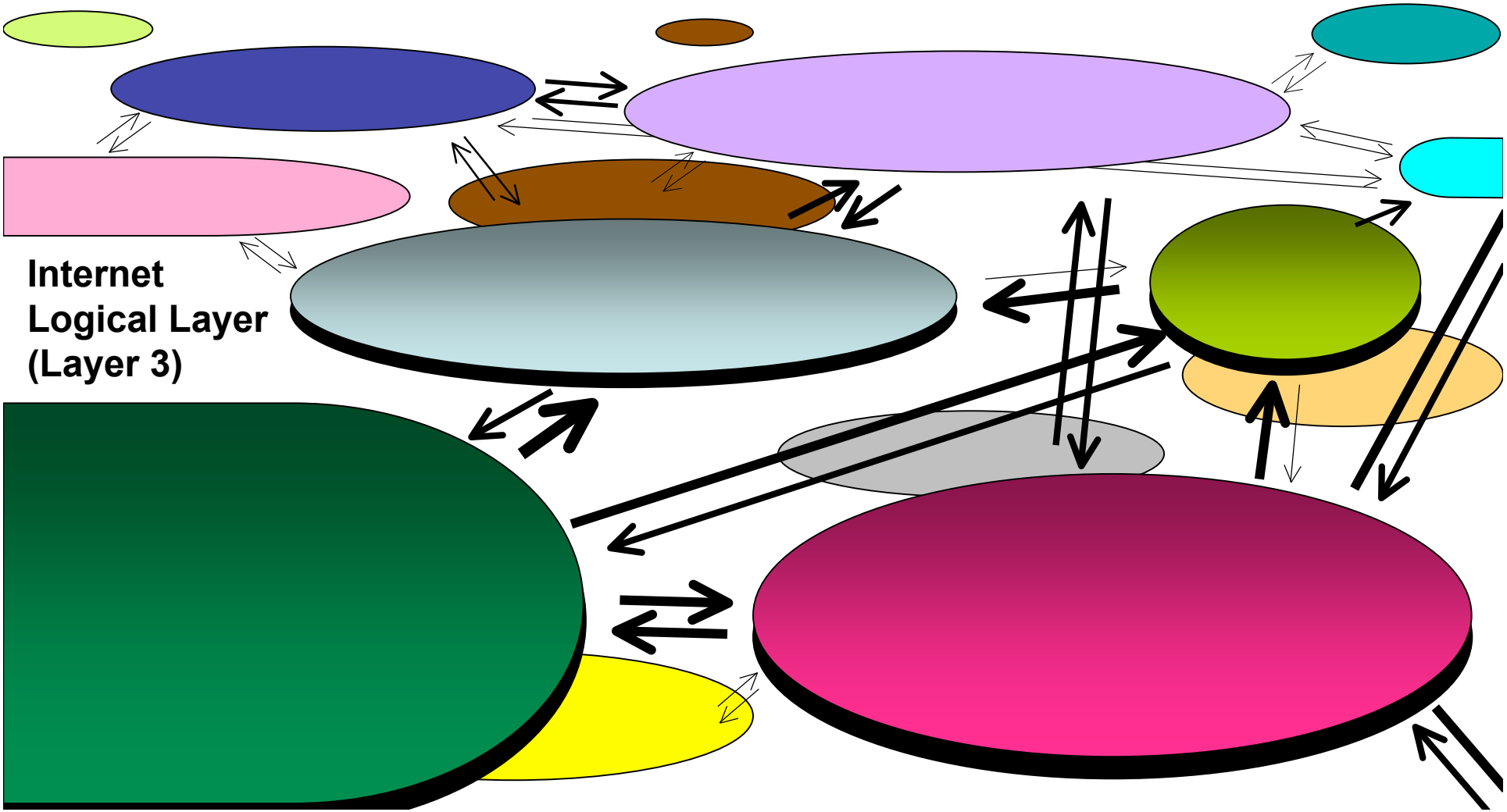
- Collection of one or more of network segments, routing between which is completely independent from the rest of the Internet
- Can be a component of one ASN, one ASN, or a collection of ASNs



ARDs, IDR, and the Internet's Logical Layer

(aka "Layer 3")

- Almost 19,000 ASNs currently in *production*
- Significant geographic/geopolitical patterns…

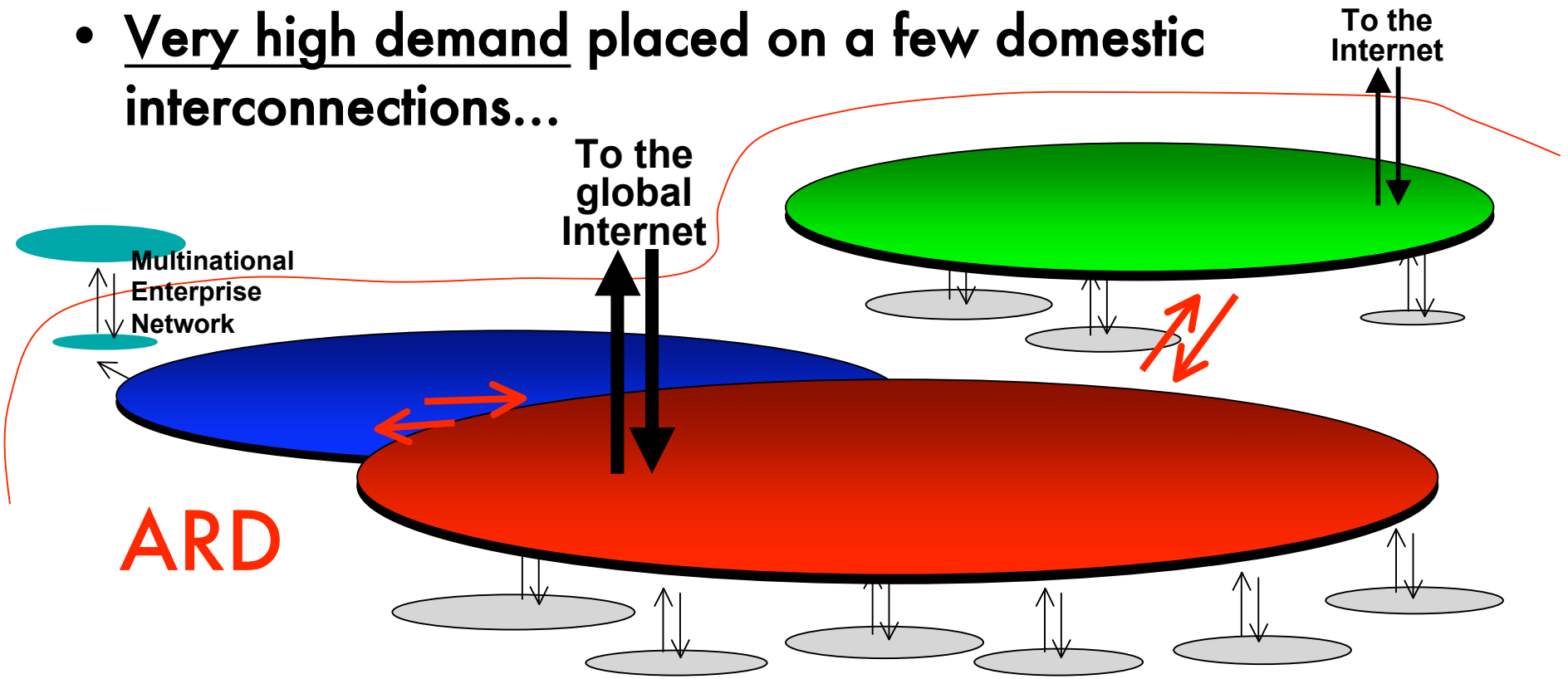


ARDs, IDR, and the Internet's Logical Layer

- Almost 19,000 ASNs currently in production
- Significant geographic patterns:
- **Cluster of countries – North America, Western Europe, Japan, some others – with many, many geographically overlapping ASNs**
  - Overlapping within countries
  - Often straddling several countries
  - Richly interconnected
- **Many countries with just a few or one ASN**
  - Little or no geographical overlap, domestically or internationally
- **China is the most prominent example of the latter**
  - **A national-scale ARD**

National ARD Growth Patterns

- Few Autonomous Systems
- Relatively flat hierarchy; lateral peering at the top only
- Very few points of interconnection with international networks
- Very high demand placed on a few domestic interconnections…



National ARD Growth Patterns: China

- Viewed from Layer 3, network growth occurs as additional IP are announced by existing or newly established networks
- Globally, new network creation is outpacing IP growth

  ... by implication, global Internet production is becoming more differentiated, distributed, specialized...

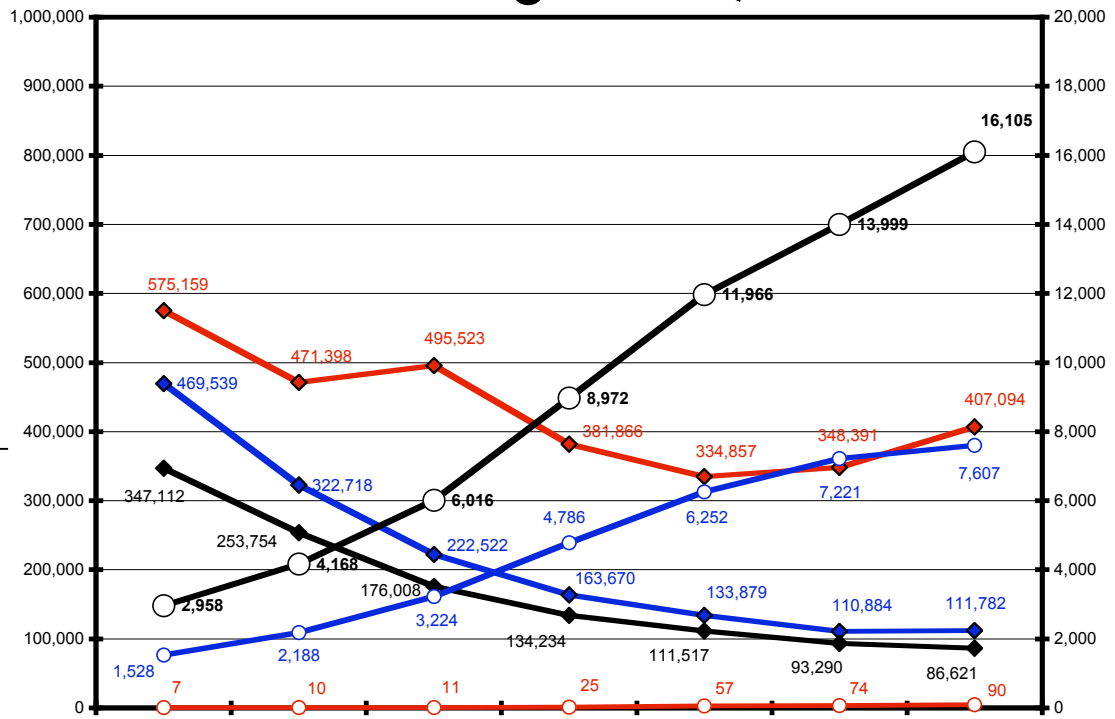
- Not so in China, which has the world's highest IP/ASN ratio

Internet Production
(Networks per National Jurisdiction)

- ASNs, China
- ASNs, US
- ASNs, World

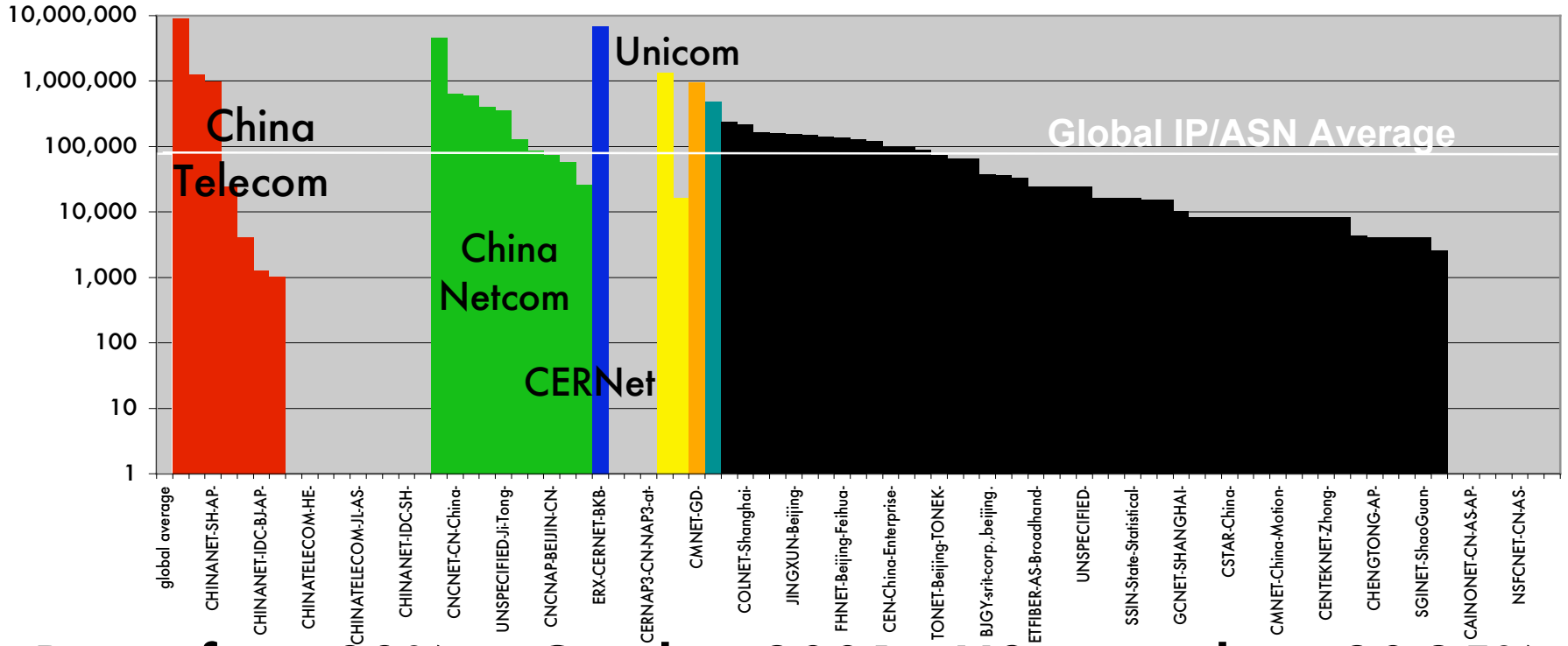
Internet Market Structure
(National Average, Internet Resources Per Network)

- IP/ASN, China
- IP/ASN, US
- IP/ASN, World

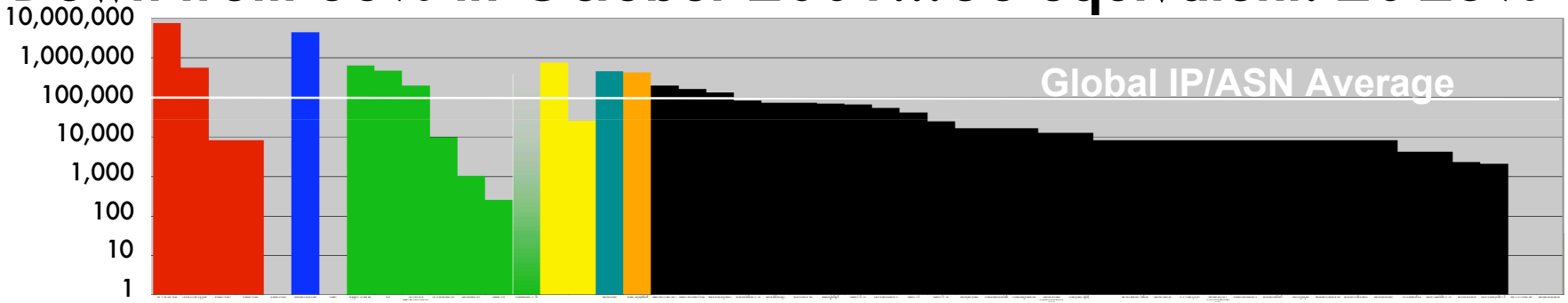


National ARD Growth Patterns: China

- 86% of Routed IP (Internet Resources) controlled by four ISPs



- Down from 88% in October 2001…US equivalent: 20-25%



What is a National ARD Good For?

- **(National) Network Security?**
  - Fewer elements exposed to international threats
  - BUT: Maginot Line, Great Wall-style defense even less effective today than in the past – "defense in depth" better…
- **Control of International Information Flows?**
  - Raises the cost/risk of "unacceptable use" for less sophisticated users
  - BUT: unlikely to scale technically or administratively; to the extent successful, is likely to foster excessive conservatism (self-censorship) …Internet's power to catalyze innovation is undermined…

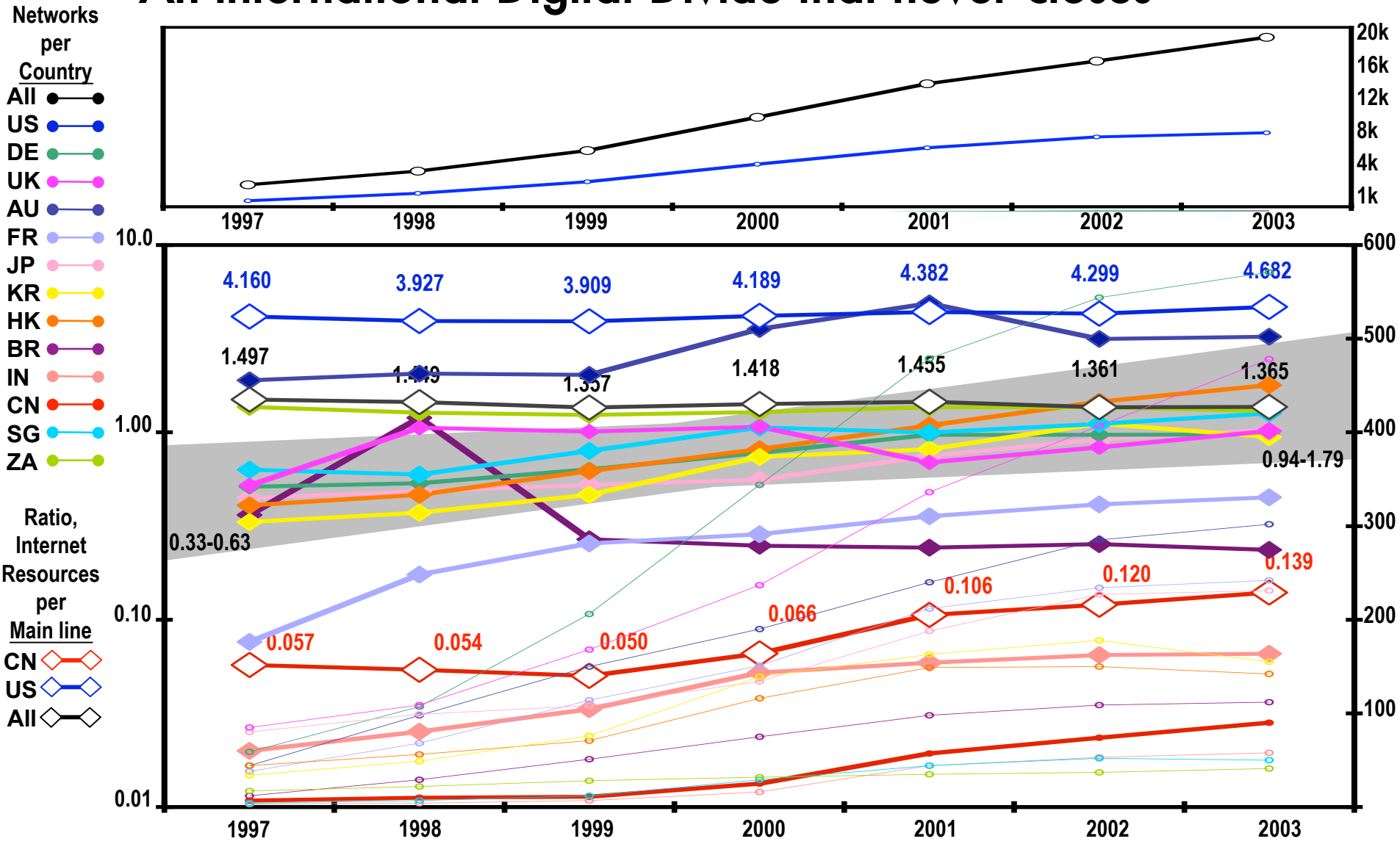
  Prediction: A future GATS / trade in services issue
- **Preservation of Profit Margins (Monopoly Rents)?**
  - Cost of Internet access will converge toward zero wherever there is optical fiber and competition among service providers
  - Preservation of revenue could be defended as necessary for infrastructure development (universal service)
  - BUT: Other ways to bring network development to the Chinese interior without slowing development elsewhere…

What is a National ARD *Really Bad* For?

- Fault Tolerant Networking
  - Without a rich mesh of interconnectivity between networks, services more vulnerable to outages and performance degradation
  - No effective infrastructure sharing regime, so "multihoming" is expensive – making outages more common.
  - EXAMPLE: latency between networks INSIDE China often worse than between networks separated by oceans, continents
- Network Service Innovation
  - Elsewhere, limited fee-for-service opportunities forces operators to work hard to optimize value of infrastructure, prompts some customers to start their own networks (creating new ASNs).
  - In a closed network economy, no optimization is possible; little incentive to enter market (thus fewer ASNs)
- International Competitiveness and the Digital Divide
  - Richly interconnected national network economies leverage each others' network infrastructures; *ceteris paribus*, their ability to create Internet resources is *always* likely to be greater than national ARDs

The Price of Low Internet Productivity

- Internet growth follows much slower telecom growth trend
- An international Digital Divide that never closes



Will China Remain a National ARD?

- China Telecom/China Netcom Restructuring
  - Intended to correct local difficulties before international competition
  - Outcome still uncertain; at best a few national network competitors will result (this would be better if coupled with UNE style sharing)
- WTO Accession
  - Layer 3 is completely off the international regulatory map, for now
  - Any future "layer-based regulatory approach" will have to address infrastructure ownership/control first
- China Netcom buys Asia Global Crossing (submarine cable)
- China Telecom Establishes the Asia Pacific Internet Exchange

  http://www.asianetcom.com/inter/index.asp?did=10&pg=Network
  http://www.chinatelecom.com.cn/isd/indexen_014.htm
  - Chinese carrier efforts to redefine the borders of the national ARD (edge of the Mainland, far shore)
  - Until the ARD barrier breaks down, these initiatives may have uncertain appeal for international network operators

Questions?
…Thanks!

治大「网路」若烹小鮮

Special Thanks
Bill Woodcock*
Randy Bush*
Oregon Route Views Project
http://www.routeviews.org/

tvest@pch.net