

# Global International Internet Capacity and Traffic Data



ITU-T SG3 Joint Rapporteur Groups  
On Internet TFM & IIC  
Meeting of April 2003

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## Key Premises: The Internet [Market] is Dynamic: It Has Changed & Will Continue to Change

- The Internet [market] has a different structure & dynamics:
  - than traditional voice telephony, and
  - than when it started. And,
- It is evolving and changing– today it has a vastly different configuration of networks & costs than five years ago... and even two years ago....
- It continues to evolve and grow to address the wide variety of market demands. These changes address most of the concerns under discussion at ITU SG-3.
- Regulations that dictate a set of structures or contractual models will constrict continued diversification and market growth
- Where specific challenges exist involving connectivity, specific and targeted (not a global) solutions should be examined.

*"Liberalization has enabled telecommunications carriers to put together "end to end" infrastructure on global and national routes." OECD 2001*

# Economic Model of International Internet is Not like Traditional Switched Voice

- A “whole circuit” model, not a “half-circuit model”
  - Everyone brings their own network TO the hub location
  - An ISP can span internationally, or regionally, or be downstream, or a mix
  - Important to understand the financial investments required
- “Hubs” are local, regional, and/or of other scope
  - From its origin in USA, Internet is now regionally and globally adaptable at multiple levels
- Naturally competitive model, adaptable, flexible, drives lowest cost for all through competition
  - The voice world is beginning to look like this too as a result of liberalization and introduction of competition

*“The major change, in terms of market structure, is that these carriers own this capacity on an end to end basis. They no longer need to purchase international half circuits originally provisioned in the monopolistic world of circuit switched networks.” (OECD 2001)*

## Internet Traffic Patterns

- As you build *local* Internet infrastructure, Internet traffic follows the pattern of voice traffic – voice traffic is primarily local and regional. (Probe Quote)
- When teledensity, Internet access/numbers of Internet users and usable content develop, very little traffic needs to cross the globe
  - Users prefer content that is tailored to local needs
  - With voice and email, much higher percentages of traffic are within nation, and region... communicating primarily with their neighbors and businesses within region. Some traffic remains international, to access specific web sites/resources.
- Investments in Regional Hubs is growing, and Regional Hubs have higher growth rates.



The Internet and the  
Public Switched Phone Network

# Internet Does Not Operate Like Bilateral Switched Voice Networks

*The Internet is An "Interconnected Network of Networks"*

- Traditional "telecom" pricing and compensation models aren't transferable to the Internet.
- Typically, each Internet operator owns its own network end to end: Operators "build" their own global networks and pay for the capital expenses and operating costs themselves.
- Internet Operators invest in extending their networks to markets, when markets are open and market opportunity/demand exists, or can be developed.
- Exceptions: closed markets where investment or ownership is prohibited; or environs where no markets yet exist, or are very high cost to serve with significant lack of market demand.
- Internet reimbursement frameworks exist, are based on competitive models, and are working.....

*"The paradigm of "one network – one country" has been replaced by a myriad of networks seamlessly operating at the national and international level. The operators of these networks enter into the best commercial arrangements for their requirements. They are free to build or buy with few barriers to entry." OECD 2001*



## The Development of the Internet:

The Internet has changed dramatically in its last five years...and again in its last two years... and more change is coming

# Global Development of Internet

1968

1970

1973

1981

1982

1983

1986

1990

1991

1993

1995

1997

2000

**1968** Advanced Research Projects Agency (ARPA): RFP for ARPANET

**1970** French CYCLADES built

**1973** First international connections to the ARPANET

**1981** Minitel deployed across France

**1982** TCP/IP adopted

**1983** MINET in Europe connected - EARN (European Academic and Research Network) established

**1986** NSFNET created (backbone speed of 56Kbps using AT&T circuits)

**1990** CA\*net (national Canadian backbone) connected

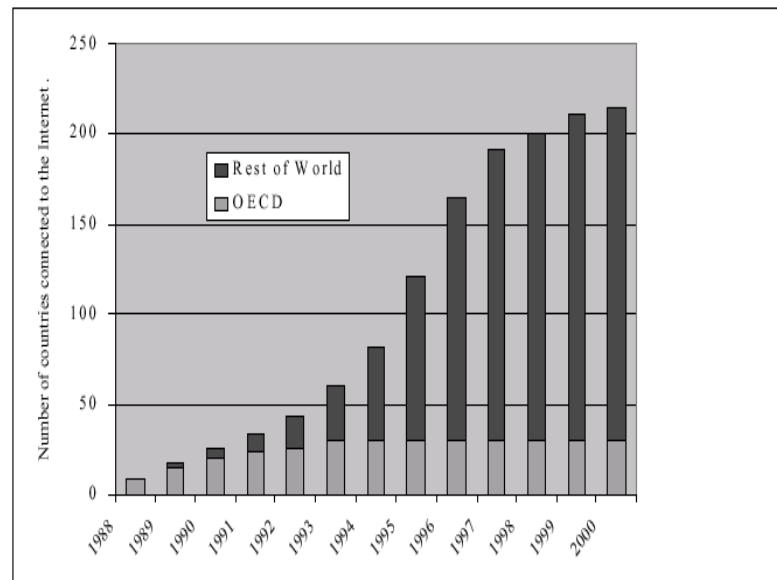
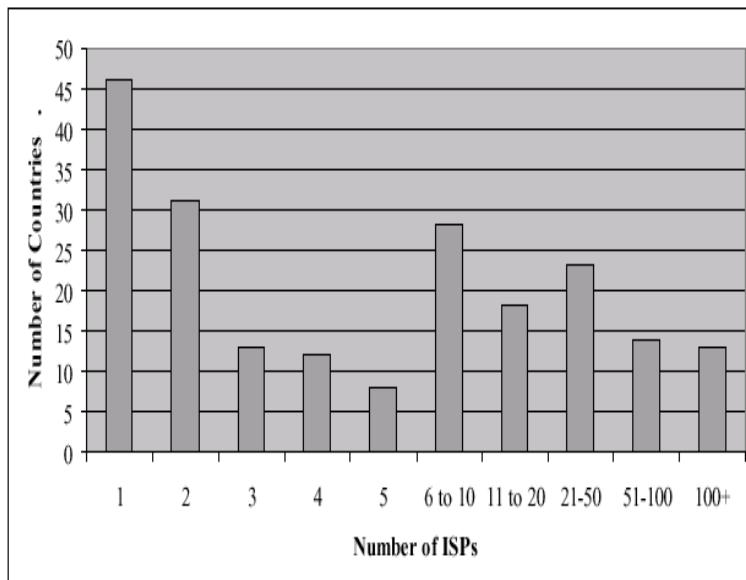
**1991** Commercial Internet eXchange (CIX) formed after NSF lifts restrictions on the commercial use; gopher released by U. of Minnesota; World Wide Web (WWW) released by CERN

**1993** NSF role ends; Mosaic Web browser released by U. of Illinois

**1995** Traditional online dial-up systems (e.g., CompuServe, America Online, Prodigy) begin to provide Internet access

**1997** AT&T Worldnet announces flat rate pricing; competitors quickly follow; consumer use of Internet grows dramatically....

In 2001, 50% of the World's Countries  
had less than 5 ISPs and  
Half the World's Countries Had Been  
Connected to the Internet for Less Than 6 Years



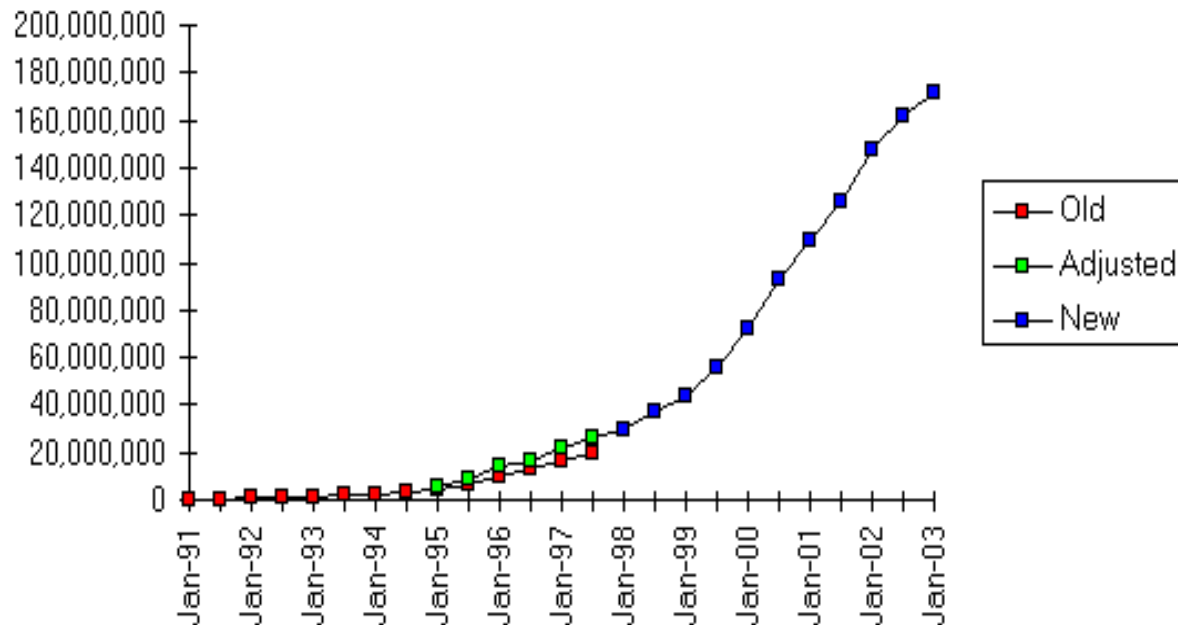
Source: Sam Paltridge, OECD Workshop on Internet Traffic Exchange, 6/01

# Facts about the Internet of 2003, and beyond

Internet no longer US centric model: Asia and Europe growing faster than N.America - Europe and Asia outpace US by 2004.

- Internet growth in hosts:

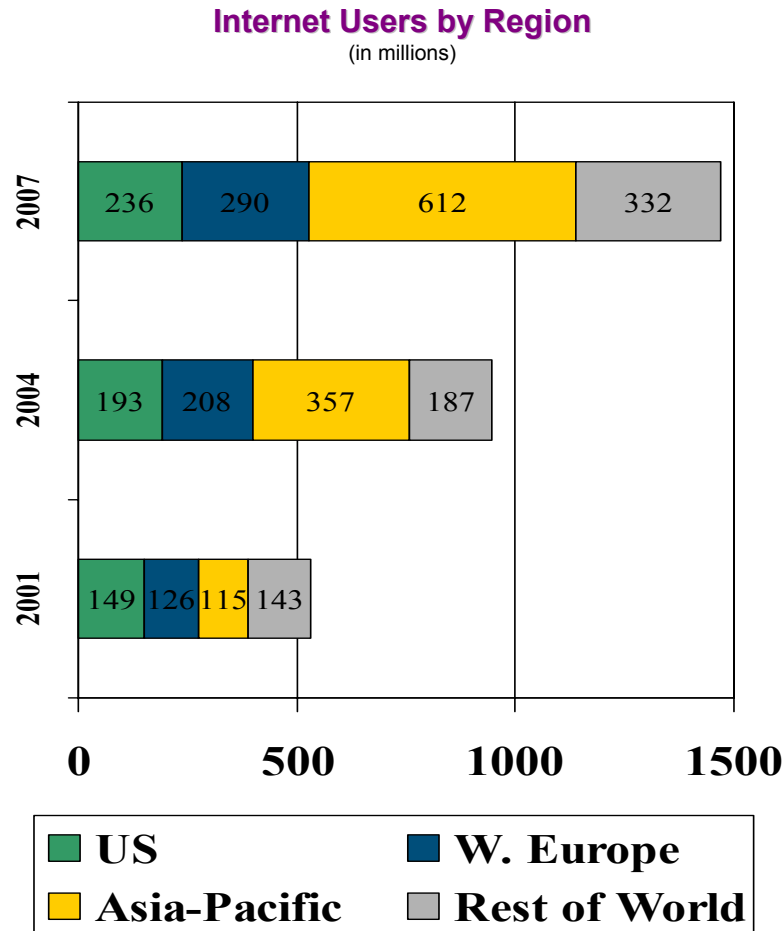
Internet Domain Survey Host Count



Source: Internet Software Consortium ([www.isc.org](http://www.isc.org))

# Facts about the Internet of 2003, and beyond cont'd

- Internet growth in users:



Source: Computer Industry Almanac



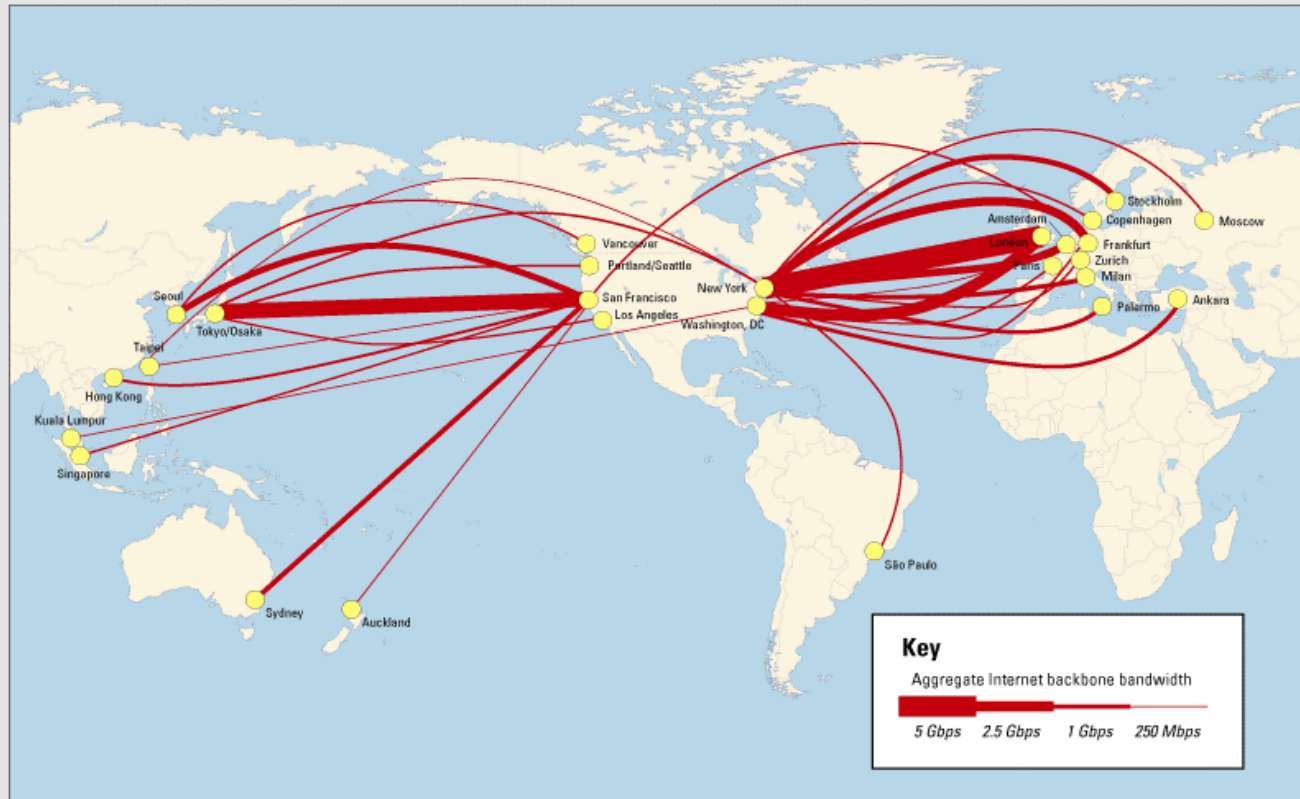
## Internet Traffic Characteristics

Then and Now :

In the Beginning, the US was the switching hub...  
things have changed dramatically

# 1999: Connectivity Between Continents - US Acted As The Switching Hub

Figure 10. Map of Major International Backbone Routes in the U.S. and Canada, 1999



Note: Map includes overseas backbone routes with at least 125 Mbps of aggregate capacity. Figures represent estimated Internet bandwidth between Consolidated Metropolitan Statistical Areas or equivalents. Domestic backbone routes are omitted. Data current to September 1999.

Source: TeleGeography *Global Backbone Database*

© TeleGeography, Inc. 1999

**The percentage of total international Internet capacity connecting to the U.S. has decreased from 46% in 1999 to 34% in 2002**

# Factors Changing U.S. Centricity



## Europe As a Model:

*"The most dramatic change in the competitive landscape was the European Union's "Big Bang" telecom market liberalization in January 1998, which opened most of Western Europe to international competition."*

- **Europe Today**

- accounts for over 80% of world's cross-border Internet bandwidth
- has four top hub cities -- London, Frankfurt, Amsterdam, and Paris
- **Data hosting and web site growth in Europe increasing rapidly; Germany and UK alone account for more than 50% of all ccTLD domain registrations; followed by Netherlands, France, Italy....**
- has achieved "***Internet regionalization***" and a stronger role ***globally***

# Growth of Communications Competition In Europe

Number of Competing International Carriers—Europe						
Country	Jul-02	Jul-01	Jul-00	Jul-99	Jul-98	Jul-97
United Kingdom	500	410	306	215	144	100
Germany	135	130	90	40	32	1
France	130	125	89	50	29	1
Italy	120	115	90	15	9	1
Sweden	120	100	60	20	13	11
Netherlands	95	85	60	30	23	3
Spain	85	75	40	16	9	1
Norway	70	57	35	14	7	1
Austria	65	54	40	17	13	1
Switzerland	60	60	50	40	21	1
Belgium	50	45	30	18	11	1
Ireland	45	50	40	25	5	3
Denmark	45	50	45	18	11	9
Finland	32	36	20	8	8	8
Portugal	32	21	15	1	1	1
Russia*	30	30	30	30	1	1
Iceland	20	14	8	3	1	1
Greece	15	2	1	1	1	1
Czech Republic	15	10	1	1	1	1
Estonia	15	10	1	1	1	1
Luxembourg	11	15	10	4	1	1
Ukraine*	2	2	2	2	2	2

## Internet Investment in Europe

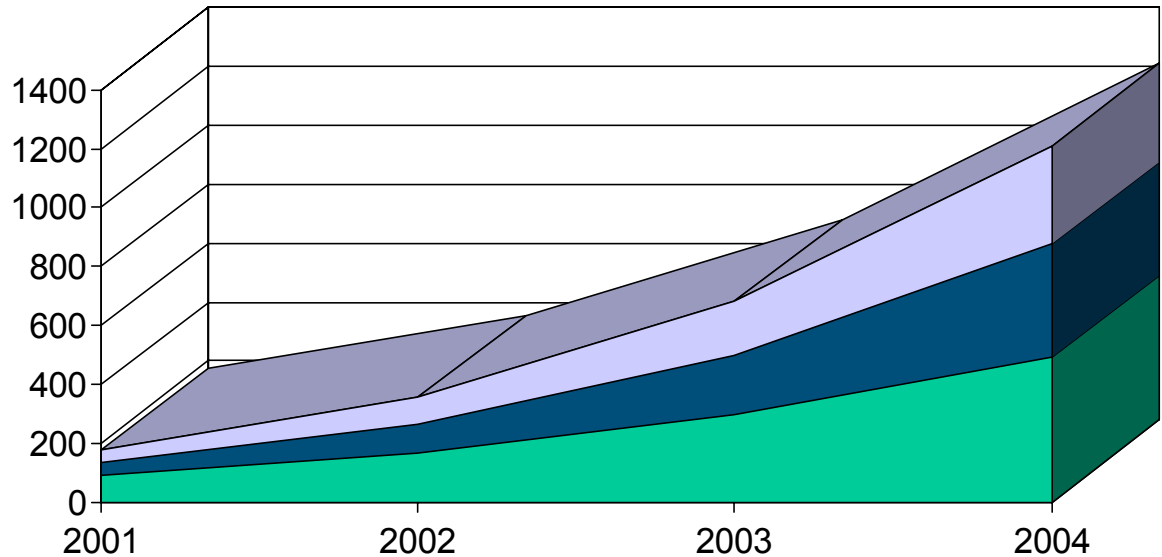
Country	Internet Exchanges	(Mbps) Bandwidth	World Rank	Hosts (000s)	World Rank	Domains (000s)	World Rank
United Kingdom	6	237504	2	2231	7	n.a.	
Germany	6	207622	3	2426.2	5	4306.6	2
France	6	191898	4	788.9	12	782.2	8
Netherlands	3	173729	5	2632.1	4	946	5
Belgium	1	81419	6	352	24	222.1	19
Sweden	4	60349	7	735.2	13	236.3	18
Denmark	1	43456	9	561.1	15	384.1	14
Switzerland	3	40,012	10	527.6	17	276.5	17
Italy	2	35771	11	680.5	14	872.9	6
Spain	2	25394	12	538.7	16	407	13
Norway	1	21,638	14	305.1	26	206.8	20
Finland	1	7820	17	886.9	11	89.7	35
Ireland	1	4203	24	128.1	34	121.1	28
Portugal	1	3522	27	246.5	27	56.1	40
Poland	1	2337	32	489.9	18	125.2	26
Luxembourg	1	1313	36	14	60	13.3	67



Driven by new traffic dynamics, regional Internet investment and competition - more traffic stays in regions. Regionalization is growing...

# Key Facts about the World's Internet Traffic: It is Changing and Becoming More Balanced

Petabytes per month (PBpm)



	<b>2001</b>		<b>2002</b>		<b>2003</b>		<b>2004</b>	
	<b>Traffic Growth</b>		<b>Traffic Growth</b>		<b>Traffic Growth</b>		<b>Traffic Growth</b>	
<b>Asia-Pacific</b>	42	198%	94	126%	187	99%	335	80%
<b>Europe</b>	44	134%	95	116%	201	112%	384	91%
<b>North America</b>	90	111%	167	85%	294	76%	492	68%
<b>Total</b>	176	132%	356	102%	681	91%	1212	78%

# International IP Traffic Originating & Terminating in Regions – increasing regionalization by ALL regions

Probe Research analyzed and divided the traffic into the following 6 regions

## **Traffic Originating in Europe**

In 2001, **71%** of traffic stayed in Europe, 28% went to North America and 1% went to the rest of the world.

In 2007, Probe Research estimates that **85%** will stay in Europe, 7% will go to North America, 4% will go to Africa and the remaining 4% will go to the rest of the world.

## **Traffic Originating in Asia**

In 2001, **12%** of traffic stayed in Asia, 79% went to North America and 9% went to the rest of the world.

In 2007, Probe Research estimates that **82%** will stay in Asia, 8% will go to North America, 4% will go to Africa and the remaining 5% will go to the rest of the world.

## **Traffic Originating in Oceania**

In 2001, **1%** of traffic stayed in Oceania, 65% went to North America and 32% went to Asia.

In 2007, Probe Research estimates that **41%** will stay in Oceania, 23% will go to Asia, 18% will go to North America, 18% will go to Europe and less than 1% will go to the rest of the world.

## **Traffic Originating in North America**

In 2001, **32%** of traffic stayed in North America, 40% went to Europe, 21% went to Asia and 7% went to the rest of the world.

In 2007, Probe Research estimates that **46%** will stay in North America, 21% will go to Europe, 18% will go to Asia and the remaining 15% will go to the rest of the world.

## **Traffic Originating in CCASA**

In 2001, **30%** of traffic stayed in CCASA, 61% went to North America and 9% went to the rest of the world.

In 2007, Probe Research estimates that **49%** will stay in CCASA, 33% will go to North America, 17% will go to Europe and the remaining 1% will go to the rest of the world.

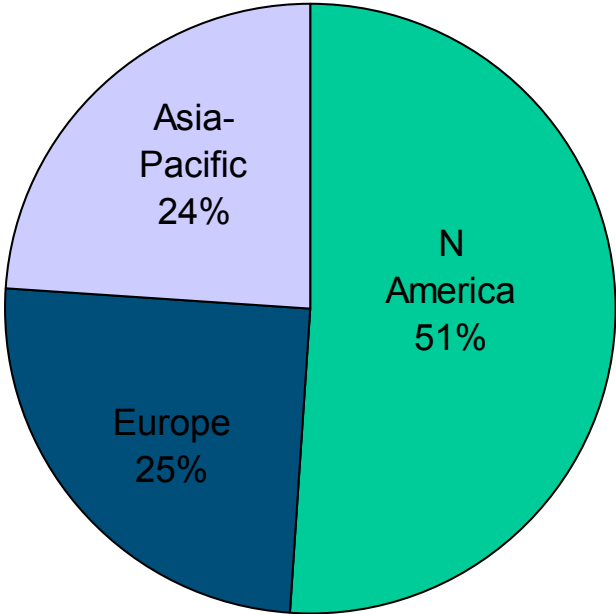
## **Traffic Originating in Africa**

In 2001, **8%** of traffic stayed in Africa, 77% went to North America and 15% went to the rest of the world.

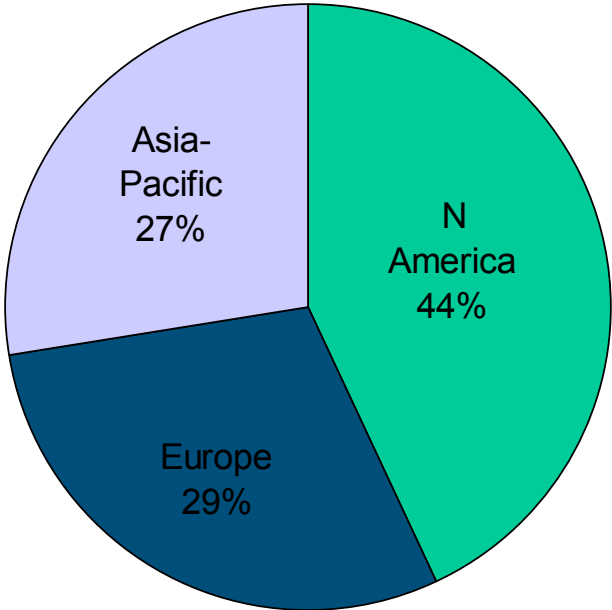
In 2007, Probe Research estimates that **53%** will stay in Africa, 17% will go to Europe, 16% will go to North America, 13% will go to Asia and the remaining 1% will go to the rest of the world.

# Global Traffic Share by Region

2001



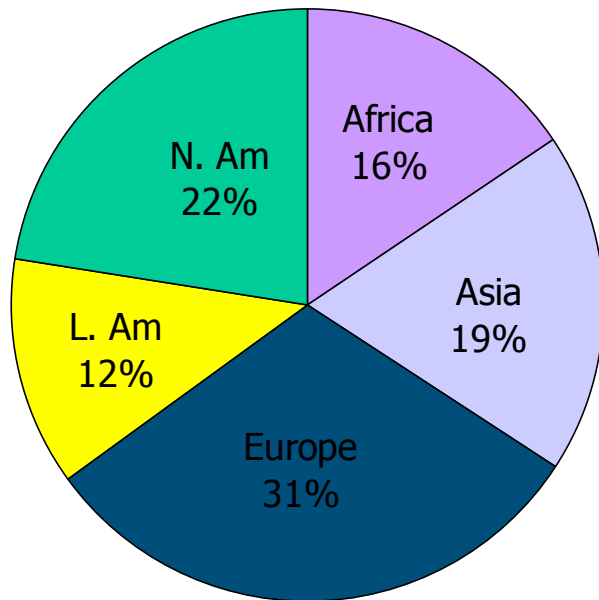
2003



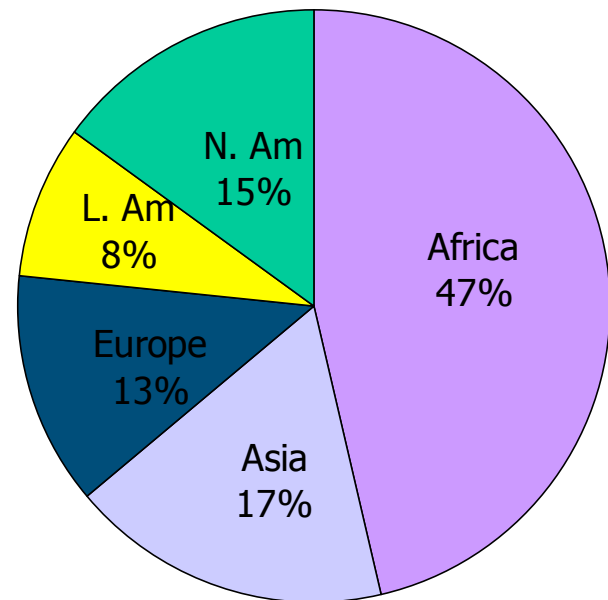
Source: RHK Inc.

# Percentage International Internet Bandwidth Growth by Region

2000



2002



Source: TeleGeography, Internet Geography 2003

## International Internet Capacity (Mbps):

Asia & L. America Grew Most Rapidly; Total EU Capacity Outstrips That Connected to N. America

- Regional Internet capacity – not connected to the U.S. – is growing more rapidly than that connected to the U.S.
  - Europe in 2002 had 698,705,000 Mbps capacity vs. 288,768,000 Mbps for North America
  - Growth from 2000-2002 in Asia was 583% and 3,373% in Latin America vs. 296% in Europe and 269% in North America.
- The percentage of total international Internet capacity connecting to the U.S. decreased from 46% in 1999 to 34% in 2002
- The majority of growth in 2002 came from “second-tier” routes within Regions that have been under-served in the past (e.g., Kuala Lumpur and Tokyo)

# Growth of Internet Independence: The World's Internet Traffic is Increasingly Using Regional Hubs, Instead of the U.S.

- With the tremendous growth in non-U.S. Internet demand, one of the important market responses has been the development of non-U.S. Internet Hubs.
  - London, Paris, Frankfurt, Amsterdam, Tokyo, Hong Kong, Singapore, Sao Paulo, & potentially Johannesburg have become significant hubs in their own regions
  - By 1999 Europe led all other regions in the number of hubbing cities
  - In 2000 Europe's lead grew slightly
  - In 2001 consolidation became apparent, Latin America grew significantly, and Asia/Pacific now led the world in the number of hubbing cities
  - The African region continues to have 3 major hubs
  - As of 2002, the top 50 Internet hubbing cities are now spread fairly equally across Europe, Asia and North America.

<b>Hubs by Region</b>	<b>1999</b>	<b>2000</b>	<b>2001</b>	<b>2002</b>
North America	<b>14</b>	<b>12</b>	<b>11</b>	<b>12</b>
Europe	<b>25</b>	<b>27</b>	<b>13</b>	<b>14</b>
Latin America	<b>2</b>	<b>2</b>	<b>8</b>	<b>9</b>
Asia	<b>2</b>	<b>9</b>	<b>18</b>	<b>15</b>
Africa	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>

Sources cited at end  
of presentation

# TeleGeography's Observations about the Rest of the World

## **Asia**

- New regional hubs of Japan, Hong Kong and Singapore have diminished the role of the U.S. in routing Asian traffic.
- China, Taiwan and Australia are still much more closely linked to the U.S. than they are to other Asian countries.

## **Latin America**

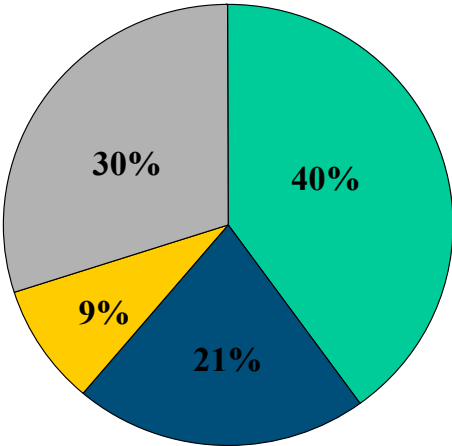
- Second fastest growing region (65%).
- Miami still the primary hub/major transit cities for the region are Buenos Aires and Sao Paolo.

## **Africa**

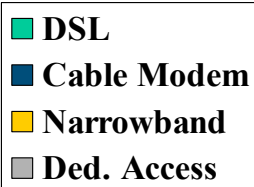
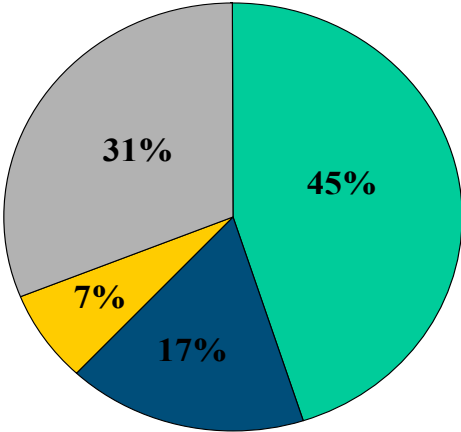
- Remains the world's least internally interconnected region, although grew the fastest in 2003 (74%).
- Reduced share of connectivity to N. America as it increased bandwidth to Europe.

# Changes which are driving domestic Internet traffic in Asia: Broadband is the Largest Source of Internet Traffic & Main Growth Driver in Asia

**2001 Sources of Traffic**



**2002 Sources of Traffic**



Source: RHK Inc.

# Broadband is Most Significant Traffic Source in Asia-Pacific; and will be for Europe in 2003

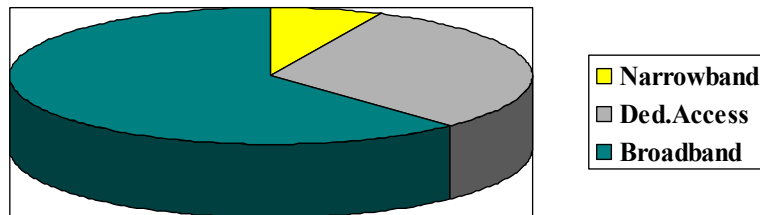
## North America 2002



## Europe 2002

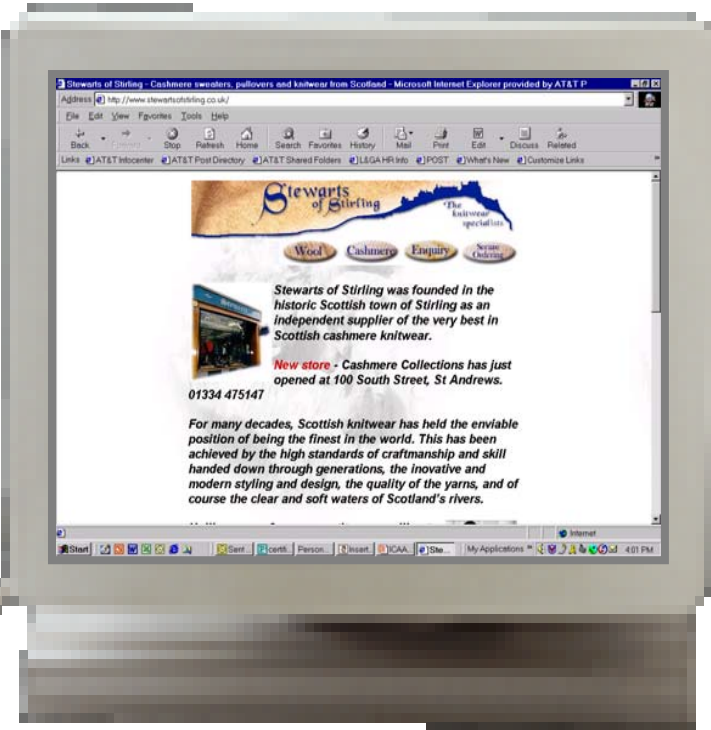


## Asia-Pacific 2002



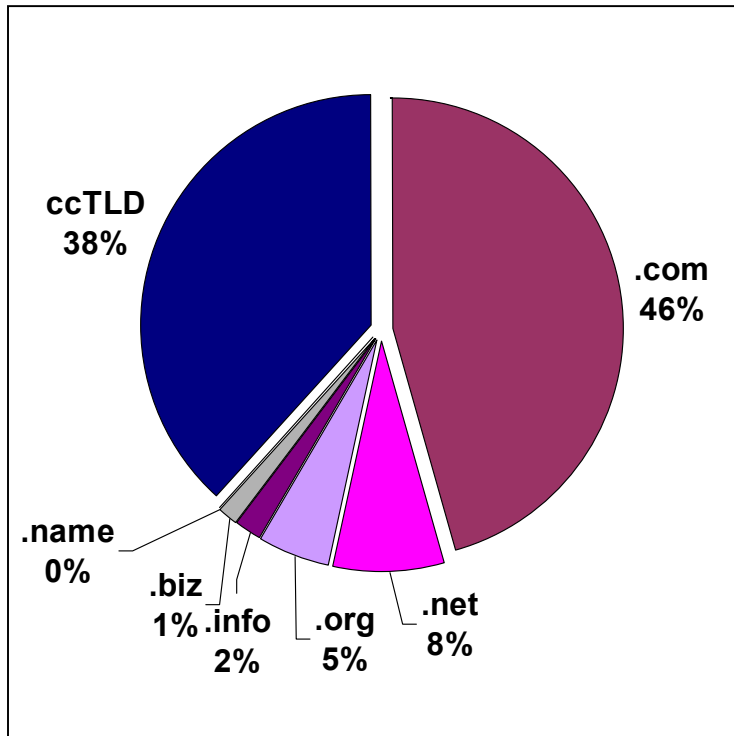
Source: RHK Inc.

# “Local” is Key and Content is becoming available Regionally



Local applications coupled with more teledensity lead to more intra-country and intra-region traffic

# Domain Names



- Approx. 47 million Domain Names are registered worldwide
  - About 60% are global top level domains (gTLDs)
  - About 40% are country codes (ccTLDs)

# Country Code TLDs (ccTLDs)

- Country code TLDs have grown significantly in registrations: UK and Germany lead followed by other European ccTLDs; China, Brazil
- Like Internet traffic, country code growth is following a regional shift and has increased significantly in the past 5 years
- All countries have an allocated country code name
- Most country codes are managed by a private sector enterprise with the advice of government
- All active country codes are showing increases in registration

## Example: 2002 ccTLD registrations

.de	Germany	5,575,284
.uk	UK	3,526,797
.it	Italy	699,356
.nl	Netherlands	695,000
.ar	Argentina	515,000
.jp	Japan	498,516
.kr	Korea	475, 855
.br	Brazil	419,363
.ch	Switzerland	400,000
.au	Australia	281,826
.ca	Canada	240,000
.cz	Czech Republic	143,510
.cn	China	127,000
.ru	Russian Fed.	120,000
.tw	Taiwan	120,000
.nz	New Zealand	118,560
.za	South Africa	110,000

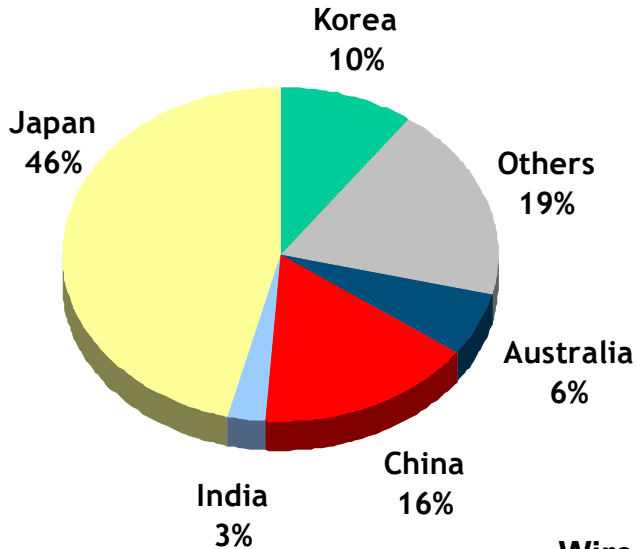
.cl	Chile	73,000
.nu	Niue	91,884
.to	Tonga	80,000
.hu	Hungary	73,000
.mx	Mexico	70,835
.hk	Hong Kong	60,195
.tr	Turkey	35,571
.my	Malaysia	30,013
.id	Indonesia	13,844
.pe	Peru	8,218
.co	Columbia	8,427
.in	India	5,154
.sa	Saudi Arabia	3,821
.ad	Andorra	897

# Probe Research Observations: Internet Traffic Patterns Are Becoming Localized and Regionalized

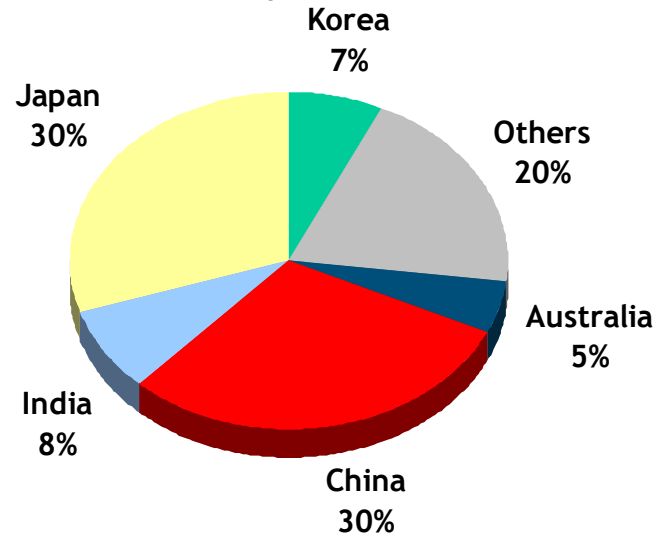
- “IP traffic is continuing to shift away from its US-centric roots and more towards regionalization.”
- “These increases in traffic volumes (due to “persistent wired connections”, e.g. DSL) and changes in the overall distribution pattern have also led to increased volumes of domestically originated and terminated traffic.”
- Example: Around 60% of all Internet traffic in Sweden originates and terminates within its national boundaries – a threefold increase from 5 years ago. 75% of all Dutch and up to 96% of all UK traffic pass through the Amsterdam IX and London IX(LINX) respectively.
- “Although HTTP applications still appears to dominate backbone traffic, there has been a sharp rise in the amount of P2P traffic detected on networks.”

# Five countries dominate Asia-Pacific telecom market

2002 AP revenues: \$324 billion



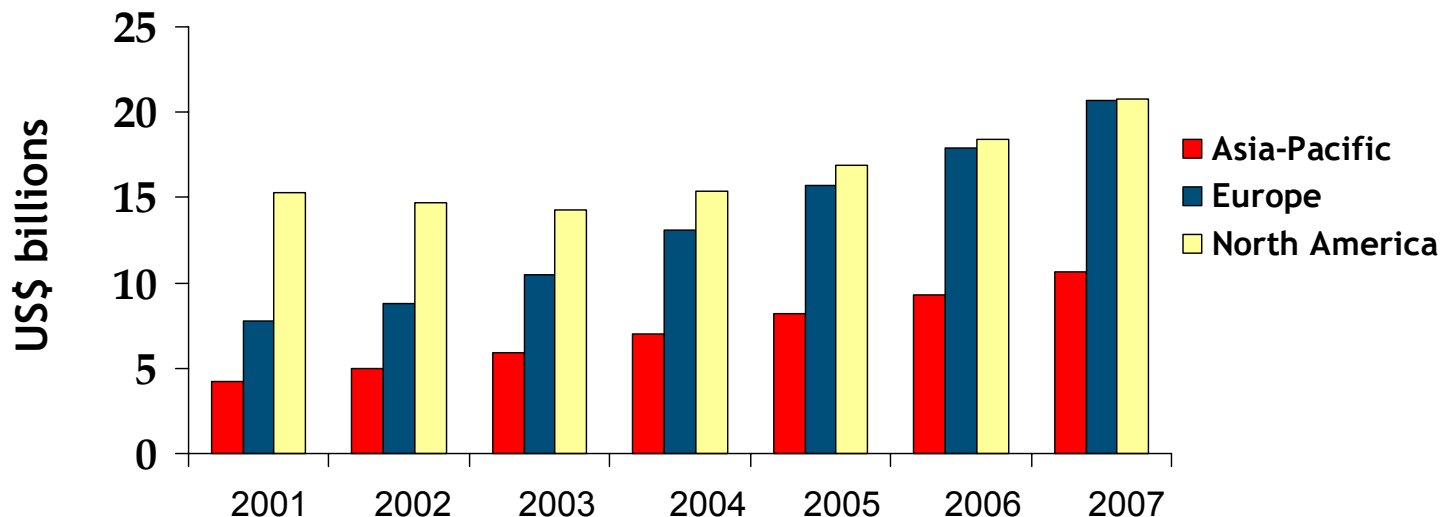
2002 AP capex: \$80 billion



Wireline + Wireless

# Internet revenues will also continue to grow, but at a slower pace

Internet backbone revenues



- USA is not the center of Internet revenues
- Europe will match N. American traffic by 2007
- Asia/Pacific will jump to 50% as high as Europe & N.America
- Asia/Pacific seem poised to eventually overtake other regions as their regional infrastructure and economies grow

## OECD Paper “Internet Traffic Exchange & The Development of End-To-End International Telecommunication Competition” (Dec. 2001)

### Conclusions:

- “As long as there is sufficient competition, and markets remain open to new entry, commercially based arrangements for the carriage and exchange of traffic will continue to develop without the need for regulatory intervention.”
- “The available evidence shows that, in liberalised markets, commercial solutions are rapidly developing, and thriving, in relations to concerns raised by some incumbent carriers who were slower to react to changes taking place in the marketplace.”
- “The result of this frenetic rollout of new infrastructure is that telecommunications carriers no longer necessarily need to be each others’ customers for connectivity or the exchange of traffic.”

## OECD's Conclusions on Developing Countries' Issues

The challenge for developing countries is to take advantage of the new environment. The available evidence indicates that in the absence of vigorous competition between ISPs, monopoly incumbents will continue to seek to extract monopoly rents from their customers. By way of contrast, liberalisation will have a number of benefits."

The barriers to developing countries taking advantage of the new environment are their monopolies.

On the other hand, in the absence of reform, developing countries will not be able to take advantage of the new opportunities created by liberalisation in the OECD area or in developing their own domestic infrastructure.



## Summary and Conclusions

## SUMMARY:

- The Internet is changing and growing regionally.
- The Internet economic model assumes a competitive environment where rational decisions will be made about investment and traffic exchange.
- An examination of the growth of regional hubs indicates significant changes in hubbing choice and diversified investment is taking place in most of the world.
- Growth rates of Internet users and traffic in countries with liberalized regulations and competitive transport are surpassing their neighbors; these countries are emerging as regional hubs.

Greater teledensity, with more Internet users, coupled with local applications leads to more intra-country and intra-region traffic, and is driving intra-country and intra-region Internet investment.

# CONCLUSIONS

Growth of Internet Regionalization and Globalization: Europe has achieved regionalization and Asia-Pacific will soon follow.

- Less of the world's Internet traffic is hubbing through North America
- More international Internet traffic is hubbing *within* Regions as operators peer with each other regionally. IXPs growing up in countries, and in regions.
- Regional transit and/or peering is often more cost-effective for customers than non-regional arrangements
- Competitive opportunities in many countries in Europe, Asia, and Latin America are leading to regional hubbing. Exceptions in closed markets; special circumstances of African countries; some small island countries
- Investments in Regional Hubs is growing, and Regional Hubs have higher growth rates

## Conclusions, cont'd.

- Internet is a “network of interconnected networks.” It is not the “one national, one network” model of traditional voice telephony.
- The Internet has no boundaries: Many operators are building multi-national networks and funding the full build-out themselves. Therefore, “cost-sharing” is irrelevant in Internet.
- Artificial constraints on competitive contractual models will restrain Internet growth & create non-rational, non-sustainable economics.
- The key to local & regional telecom/Internet development is open, competitive markets. Where specific challenges exist, specialized solutions which draw on expertise external to SG-3 needed. “Not a one size fits all” in developing solutions to connectivity challenges.
- *“Internet growth is directly proportionate to the degree of liberalization of the market.”  
See: Regulation and Internet Use in developing countries”, Scott Wallsten, Dec. 2002*

# Formula for International Regionalization and Globalization of the Internet

- Legal/regulatory environments that encourage the competitive provision of bandwidth and services, both locally, nationally, and internationally
- Allow time for bandwidth to be deployed – see change in just last two years as example.
- Allow and support flexible investment models.
- Where demand is lagging, or in special circumstances where other help is needed, encourage development of regional IP hubs [broader than SG-3; ITU-D, examine other opportunities and options, not a “one size fits all”]
- Encourage the development of government as a user; as well as supporting the development of content through other free market mechanisms.
- Allow and encourage competitive provision of transit/peering services in country – with competitive pricing models.

# SOURCES AND RESOURCES

AT&T is grateful to the following:

- Telegeography 2000 and 2003
- RHK, Asia-Pacific Internet Traffic and Revenues. *[RHK's report focuses only on 3 regions]*
- Probe Research, January 2003
- OECD's study, Internet Traffic Exchange and the Development of End-to-End International Telecommunications Competition



Thank You

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Corporate maps showing global networks and connectivity are provided in a separate document