Changing the IP Fairness Rule With Flow Management

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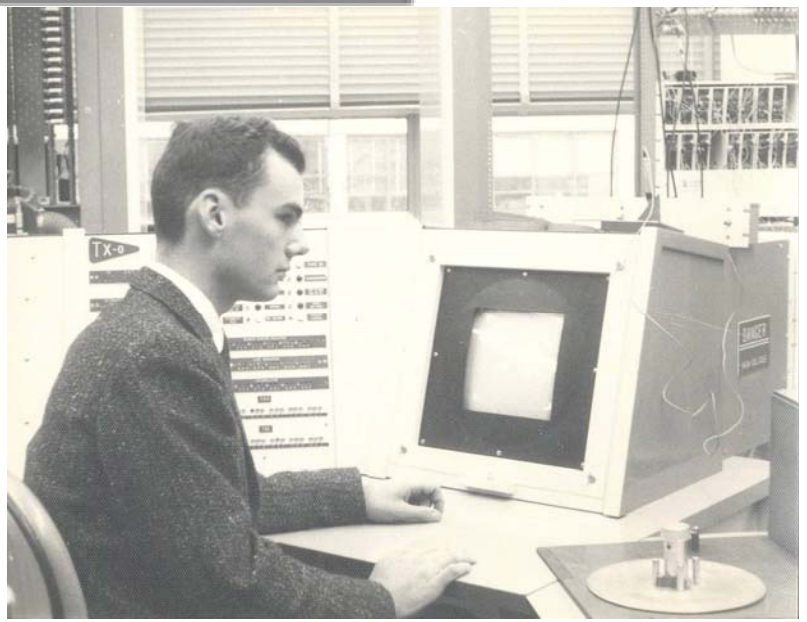
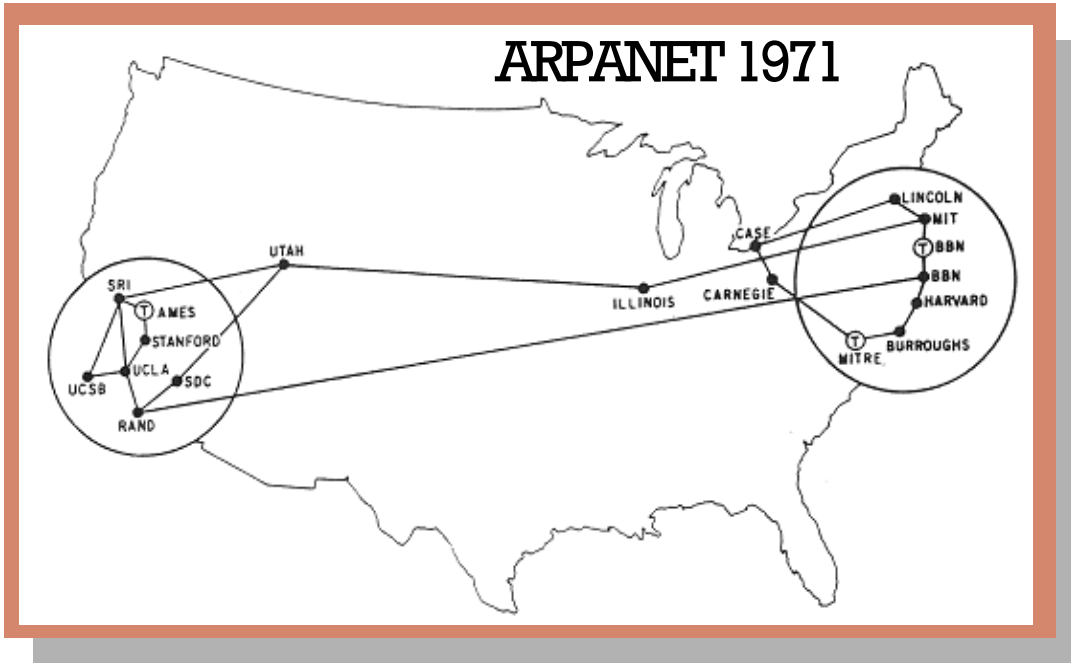
The Beginning of the Internet

ARPANET became the Internet

- **1965 – MIT- 1st Packet Experiment -Roberts**
- **1967 - Roberts to ARPA – Designs ARPANET**
- **1969 – ARPANET Starts – 1st Packet Network**
- **1971 – ARPANET Grows to 18 nodes**

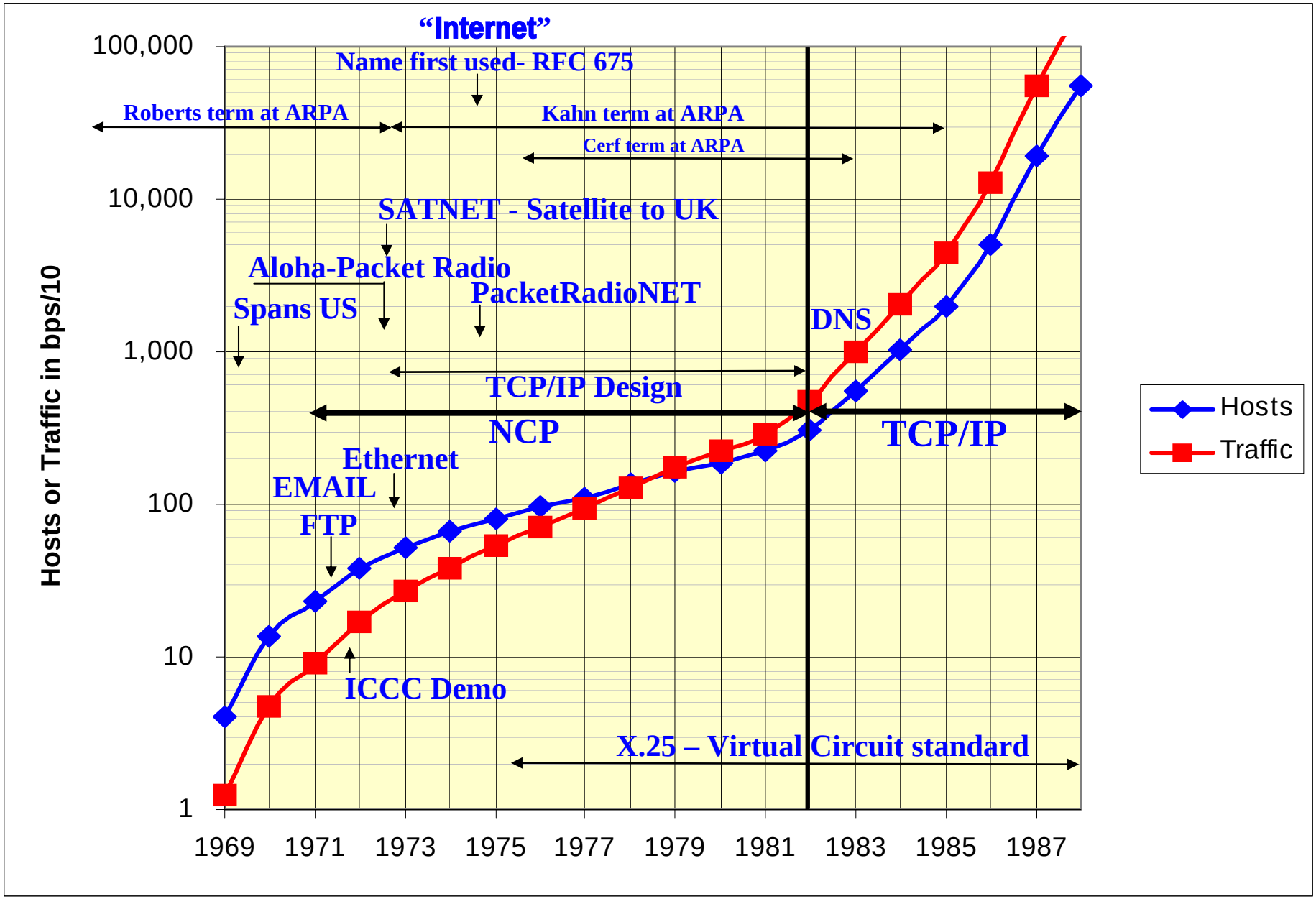


Roberts at MIT Computer



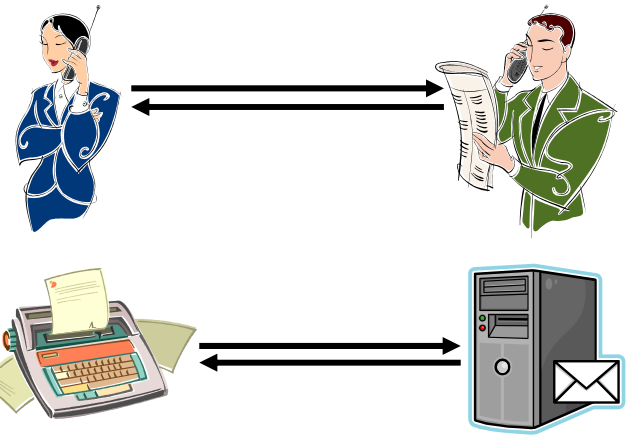
- **1983 – TCP/IP installed on ARPANET – Kahn/Cerf**
- **1986 – NSF takes over network - NSFNET**
- **1991 – Internet opened to commercial use**

Internet Early History



Fairness in the beginning

- A flow was a file transfer, or a voice call
- The voice network had 1 flow per user
  - All flows were equal (except for 911)
  - Early networking was mainly terminal to computer
  - Again we had 1 flow (each way) per user
  - No long term analysis was done on fairness
- It was obvious that under congestion:



Users are equal

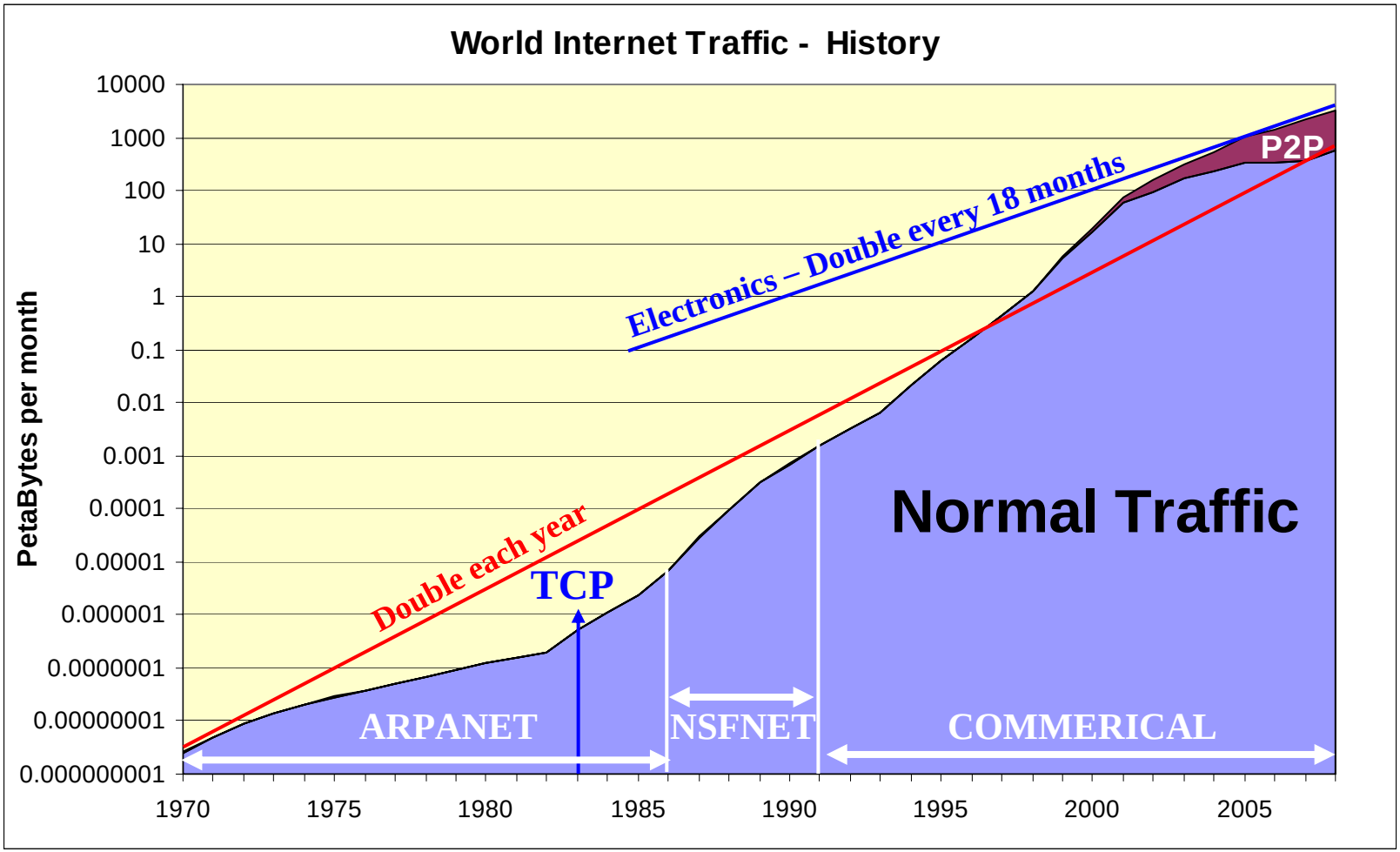
thus

Equal Capacity per Flow

was the design

Internet Traffic

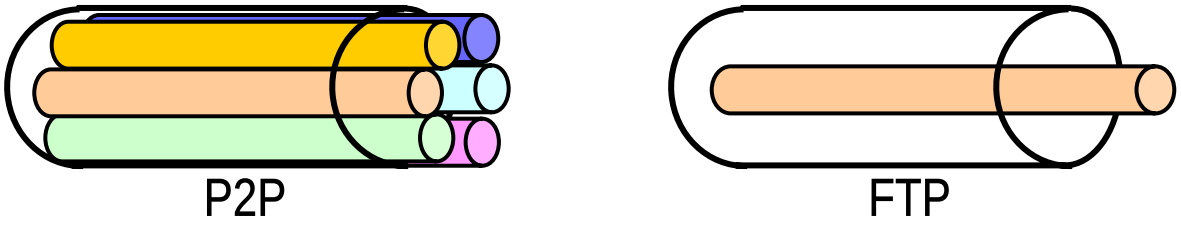
Grown 10^{12} since 1970



In 1999 P2P applications discovered using multiple flows could give them more capacity and their traffic moved up to 80% of the network capacity

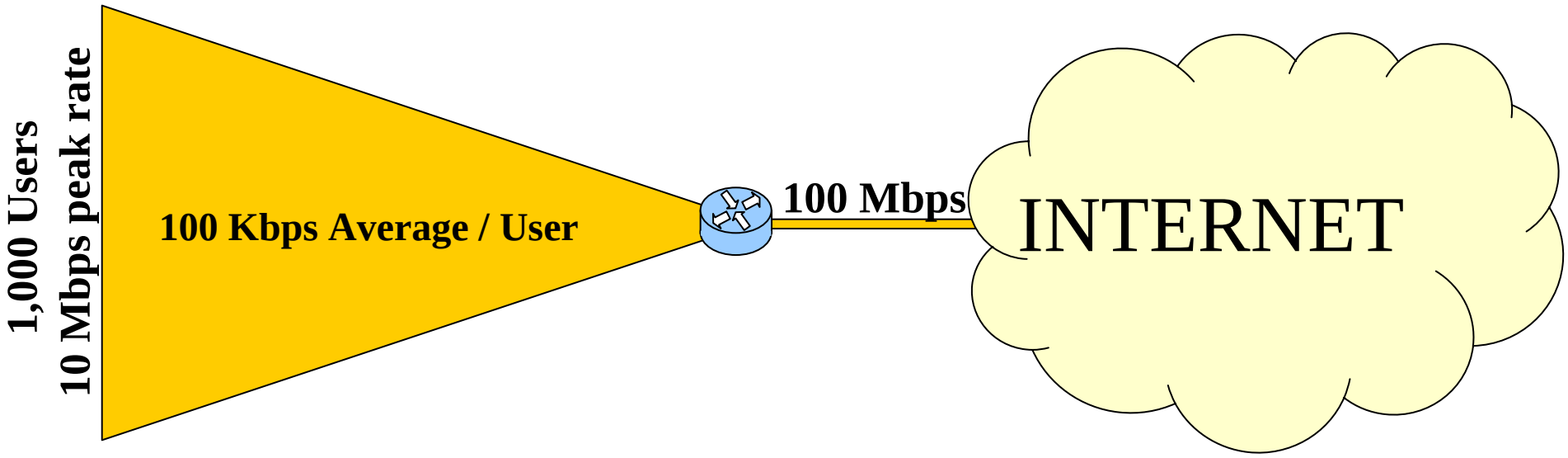
Where is the Internet now?

- The Internet is still **equal capacity per flow** under congestion
- Computers, not users, now generate flows
  - Any process can use any number of flows
  - P2P takes advantage of this using 10-1000 flows



- Congestion typically occurs at the Internet edge
  - Here, many users share a common capacity pool
  - TCP generally expands until congestion occurs
  - This forces **equal capacity per flow**
  - Then the number of flows determines each users capacity
- The result is therefore unfair to users who paid the same

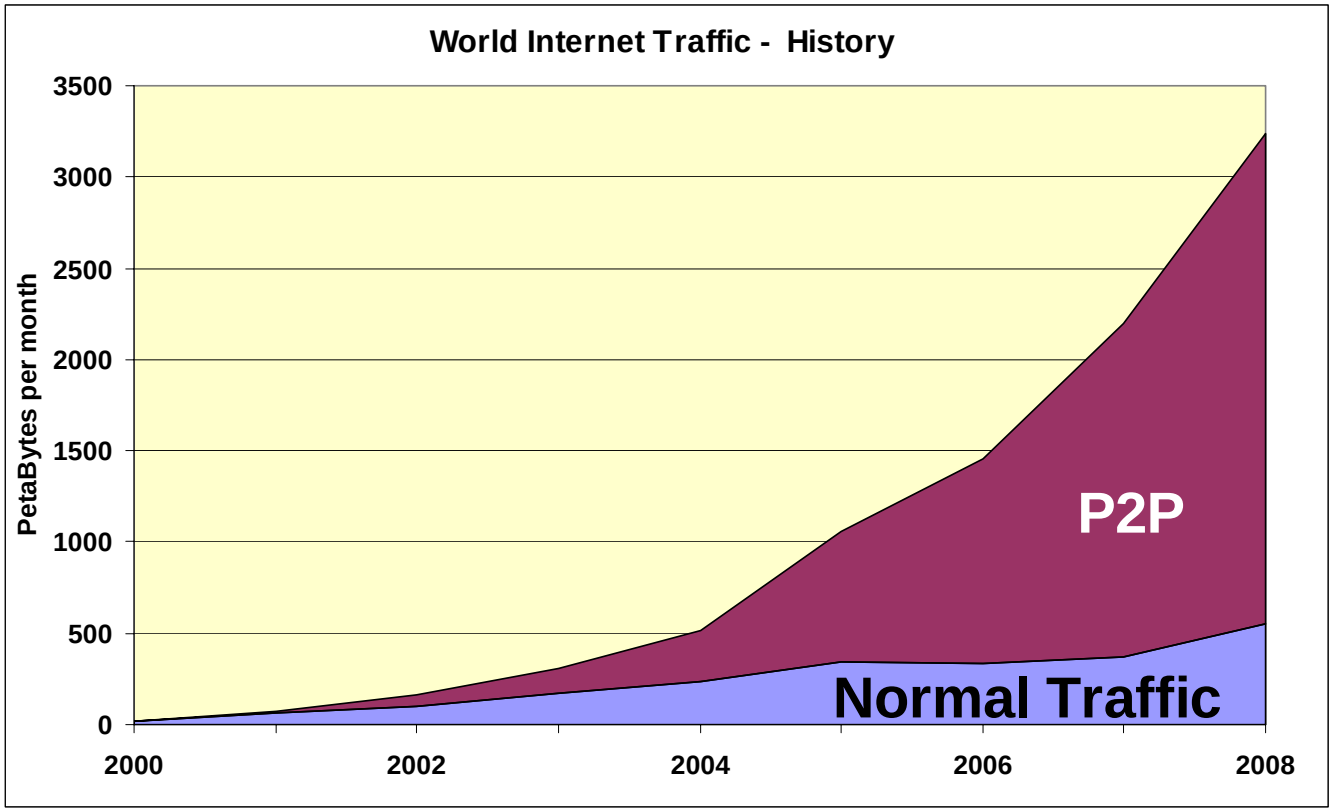
Typical Home Network Access



- Internet Service Providers provision for average use
- Average use today is about 100 Kbps per subscriber
- Without P2P all users would usually get the peak TCP rate
- With >0.5% P2P users, average users see much lower rates

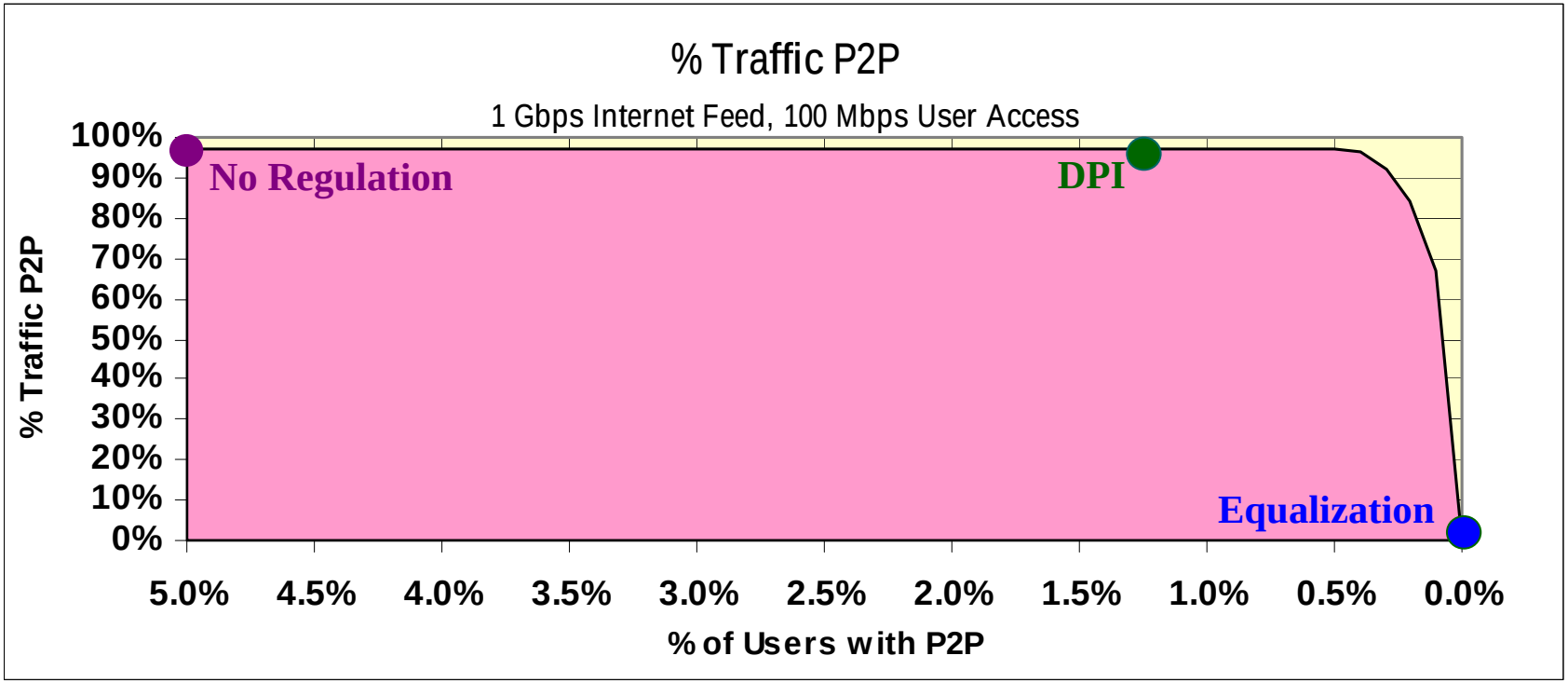
Internet Traffic Recently

- Since 2004, total traffic has increased 90% per year, about average
  - P2P has increased 91% per year – Consuming most of the capacity growth
  - Normal traffic has only increased 22% per year –Significantly slowdown from past
- Since P2P slows other traffic 5:1, users can only do 1/5 as much
- This may account for the normal traffic growth being about 1/3 what it should be with normal growth



Deep Packet Inspection (DPI) Fails to Stop P2P

- DPI currently main defense – but has problems with encrypted P2P
  - Studies show it detects < 75% of P2P – reducing the P2P users from 5% to 1.3%
  - As P2P adds encryption, DPI detection misses 25% already and encryption growing
  - Remainder of P2P simply adds more flows, again filling capacity to congestion



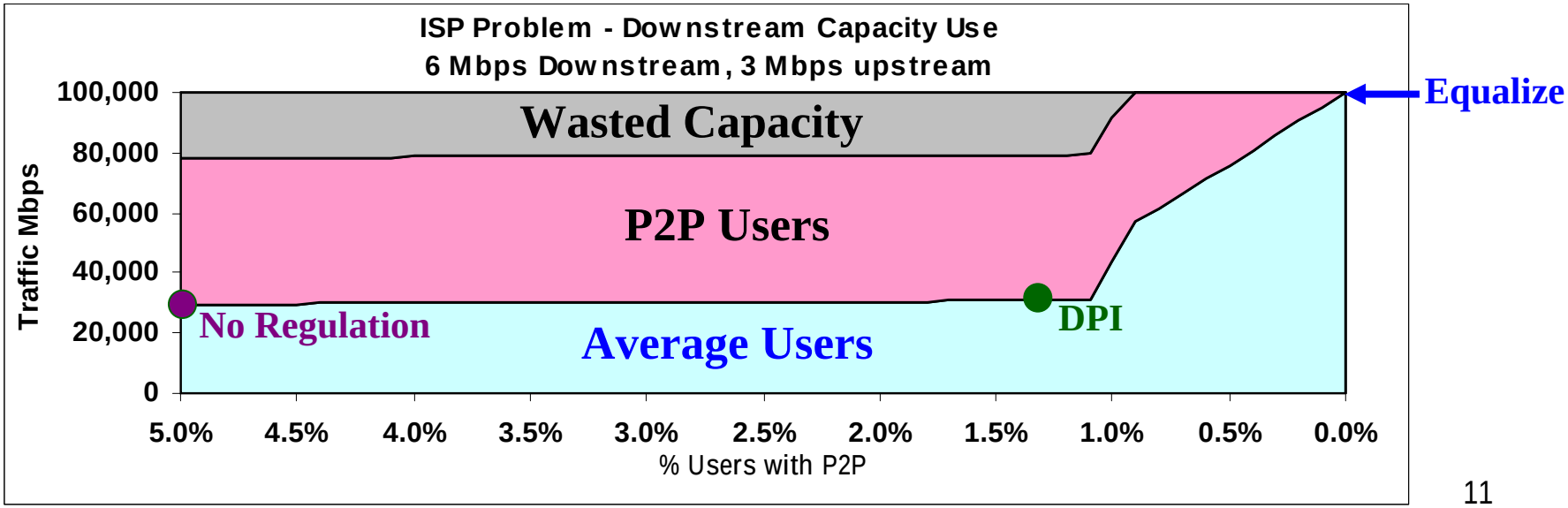
Result – a few P2P users can consume almost the entire network capacity

A New Fairness Rule

- Inequity in TCP/IP – Currently equal capacity per flow
  - P2P has taken advantage of this, using 10-1000 flows
  - This gives the 5% P2P users 80-95% of the capacity
  - P2P does not know when to stop until it sees congestion
- Instead we should give equal capacity for equal pay
  - This is simply a revised equality rule – similar users get equal capacity
  - This tracks with what we pay
  - If network assures all similar users get equal service, file sharing will find the best equitable method – perhaps slack time and local hosts
- This is a major worldwide problem
  - P2P is not bad, it can be quite effective
  - But, without revised fairness, multi-flow applications can take capacity away from other users, dramatically slowing their network use
  - It then becomes an arms race – who can use the most flows

The Impact on ISP's

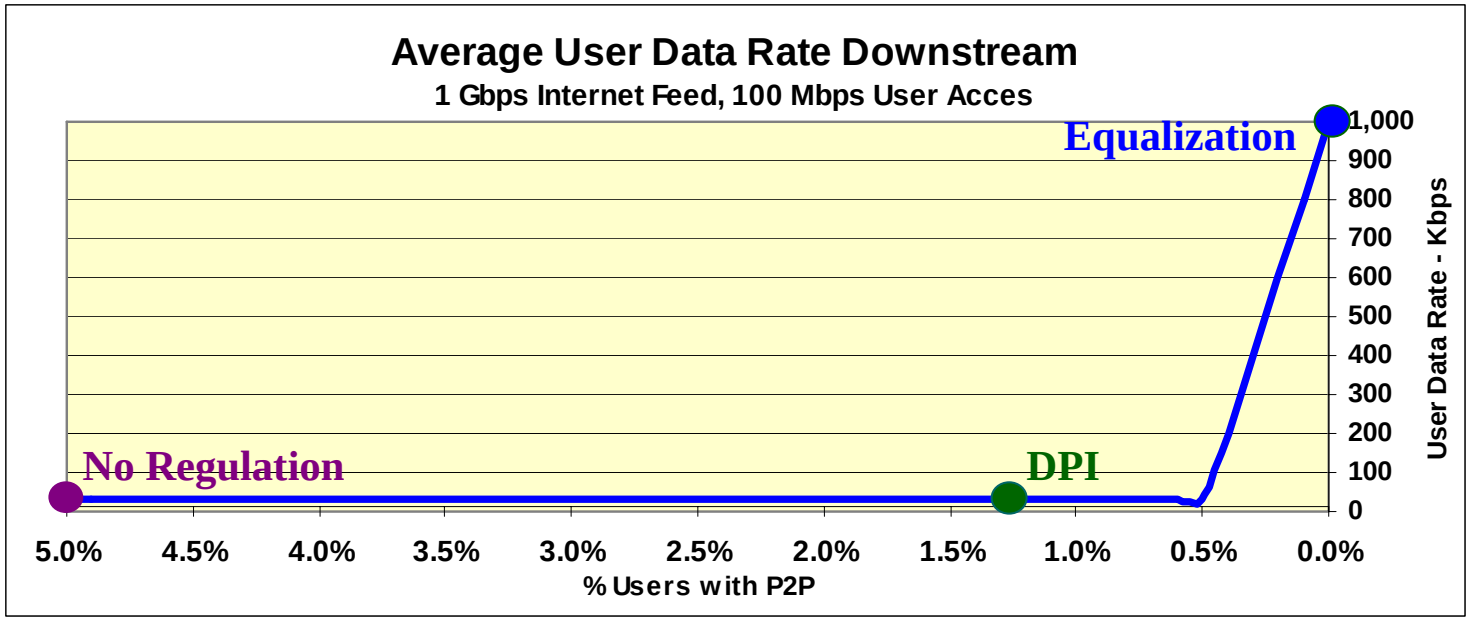
- Uncontrolled P2P growth slows normal traffic, users upset
- ISP's cannot win by adding capacity – P2P applications use it
- DPI has been tried but is less than effective
  - Also targeting only P2P without fairness censured by FCC
- Unless a fair solution is deployed, service will deteriorate
  - All applications will consider using multi-flows
  - This leads to a major collapse of service levels world wide



Asymmetric service – Upstream is congested by P2P and downstream limited by slow ACK's

The Impact on Average Users

- Uncontrolled P2P impacts normal users if any congestion
  - P2P generally expands until it sees congestion
  - Congestion is not normally that visible – 50% average is sufficient
  - The short overload peaks cause delay, loss and flow slowdown
- Average Users flows run at speed of P2P flows
  - P2P can use lots of very low speed flows



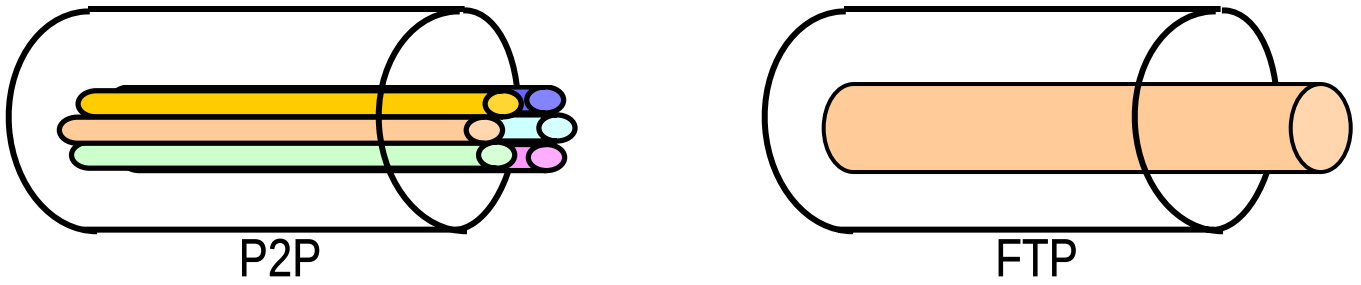
Result – Average user only gets 30 Kbps per flow – 3% of expected

We Must Resolve Unfairness Soon

- Any application that uses more flows gets more capacity
- This capacity is often taken at the expense of other users
- P2P started the trend to use multiple flows - now up to 1000
- However, to compete, other applications will use multi-flows
  - FTP and HTTP could go to using 1000 flows to compete
  - Soon all ports will be used and NAT will fail
- Also, UDP without flow control could be used to compete
- In either case the Internet will be in trouble

Revised Fairness Criteria

- We need not stick with "Equal Capacity per Flow"
- That was our concept in the early days – one flow per person
- Now, computers generate the flows, not humans
- We provide or sell peak capacity to each user
- We should provide "Equal Capacity per User" when overloaded
  - In general: Equal Capacity for Equal Pay
- Today's technology allows rate control of every flow
  - For multi-flow unfairness – divide capacity equally between users
  - P2P still works, privacy maintained, and most users run 5-10 times faster



Equal Capacity per User

Why is it Important to Change Fairness Rule?

- P2P is attractive and growing rapidly
- It cannot determine its fair share itself
- The network must provide the fair boundary
- Without fairness, normal users will slow down and stall
- Multi-flow applications will be misled on economics
  - Today most P2P users believe their peak capacity is theirs
  - They do not realize they are slowing down other users
  - The economics of file transfer are thus badly misjudged
  - This leads to globally un-economic product decisions
- User equality will lead to economic use of communications

What about Monitoring Only?

- If it is not desired to control user activity dynamically:
- All multi-flow (MF) users can be detected:
  - DPI is not required, application recognition is unnecessary
  - If a user is using more than X flows and Y Kbps,
  - And this persists for unusual periods,
  - A NetFlow record can be produced for each long flow
  - Each record should include the start and end time & bytes
  - These records can be stored any period desired
- All MF users are then clearly listed in a NetFlow collector
- This does not enforce fairness but helps control abuse

Summary

- P2P applications add flows until congestion occurs
- Even if P2P users are reduced to 0.5% of the total users, they will still fill the upstream capacity to congestion
- The average user suffers a major throughput reduction
- This will get worse as more applications use many flows
- The cause is the old rule of equal capacity per flow
- This needs to change to equal capacity for equal pay
- Then all users will get what they pay for
- And 95% of the users will see a major throughput gain