



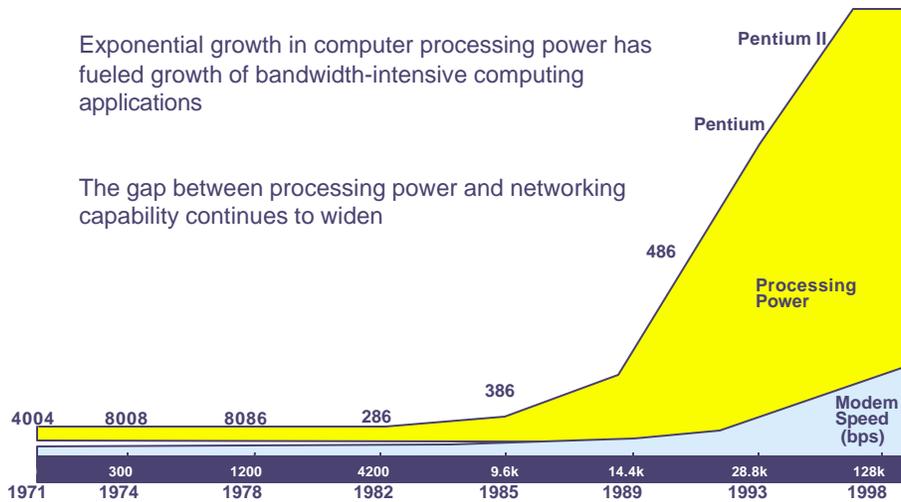
## Broadband Satellite Systems Technology

NIST Panel Discussion  
November 17, 1999

### Communications capabilities have not kept pace with the growth of computer processing power

Exponential growth in computer processing power has fueled growth of bandwidth-intensive computing applications

The gap between processing power and networking capability continues to widen

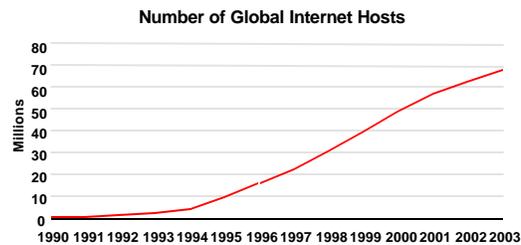
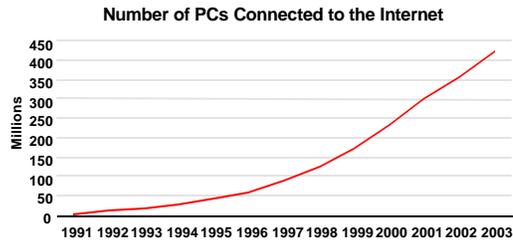


Source: Intel and Datapro Reports



## Internet growth shows the demand for broadband...

Both the number of PCs connected to the Internet as well as Internet sites are continuing to grow at astonishing rates

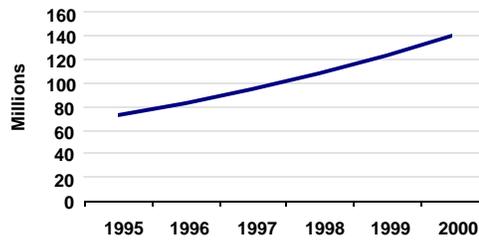


Source: Analysys

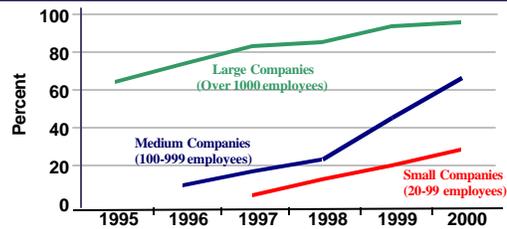


## As does the growth in enterprise connectivity

**PCs Connected to LANs**



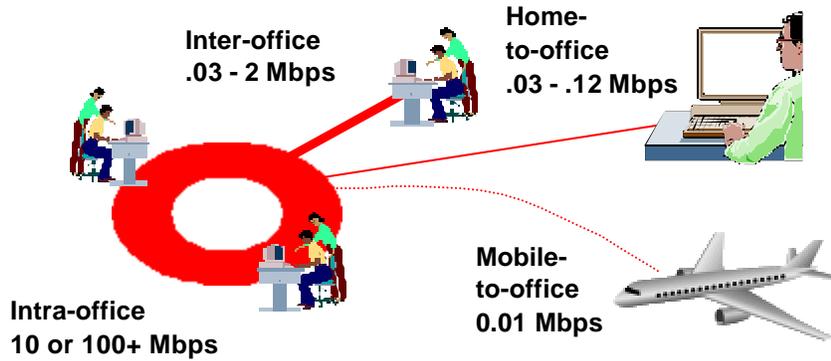
**US Companies Connected to the Internet**



Source: Aberdeen Group, Inc. courtesy of U.S. Department of Commerce and Forrester Research



**Today, networking speeds drop rapidly away from the central office**



**Typical Requirements...**

Application	BER	Max Delay	User Data Rate	
			Receive	Transmit
PC Networking	$10^{-6}$	200 ms	64 kbps	64 kbps
Email	$10^{-6} - 10^{-4}$	5 min	5 kbps	5 kbps
Paging	$10^{-6} - 10^{-4}$	5 min	5 kbps	5 kbps
Web Browsing	$10^{-6}$	500 ms	64 kbps	5 kbps
Database Access	$10^{-6}$	500 ms	2 Mbps	100 kbps
Telephony	$10^{-4} - 10^{-3}$	250 ms	64 kbps	64 kbps
Video Phone		200 ms	64kbps-1Mbps	64kbps-1Mbps
Video Conference	$10^{-6}$	200 ms	64kbps-2Mbps	64kbps-2Mbps
Tele-medicine	$10^{-6}$	200 ms	64kbps-2Mbps	64kbps-2Mbps
Tele-education	$10^{-6}$	200ms-1s	1 Mbps	64 kbps



## Key Goals in Network Design

- Deploy single flexible core architecture to support many *External Network Protocols*.
  - IP, ATM, FR external protocols (and the devices associated with them) expected to evolve during implementation and operation of the satellite network.
- Work as seamlessly as possible with existing customer networks and equipment.
  - Coexist with both server- and router/switch- type devices.
  - Integration with customer management frameworks
- Limit new hardware design required to connect to Network.
- Provide full range of QoS required for multi-application environments.



## Examples on Network Convergence

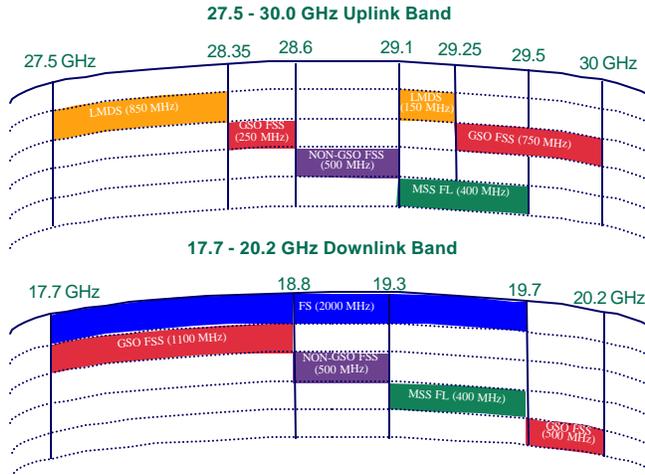
- IP
  - Best Effort
  - RSVP and Integrated Services
  - Differentiated Services
- ATM
  - UNI 3.1, UNI 4.0
  - CBR, VBR and UBR services
- Frame Relay
- Voice
  - Based on packet-based gateways with full support for PSTN signaling.
- Circuit Transport
  - T1/E1



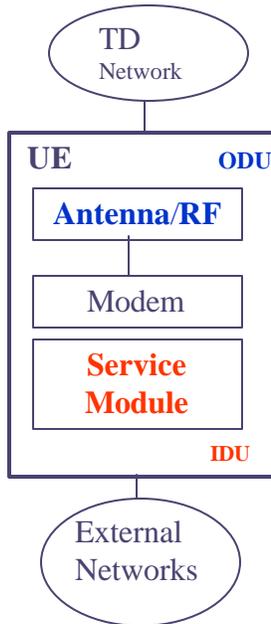
## U.S. Ka-Band Plan Primary Allocations

US Federal Communications Commission has designated 500 MHz to enable Broadband NGSO.

- FS  
Fixed Service
- LMDS  
Local Multipoint Distribution Service
- GSO/FSS  
Geostationary Orbit Fixed Satellite Service
- Non-GSO/FSS  
Broadband Non-Geostationary Orbit
- MSS/FL  
Mobile Satellite Service Feeder Link



### Ka-band Satellite Systems: Ground Segment



#### Function

XT: 28.6-29.1 GHz  
RCV: 18.8-19.3 GHz  
EIRP: 43 dB-53dB, G/T: 6 dB-12 dB  
RHCP or LHCP (switchable)

Demodulate/Decode 500 MHz signal  
Process a beacon signal  
Filter Packets  
Secure billing, authentication, and NM

Protocol adaptation  
Address resolution  
BoD requests  
SP functions

IPv4, IPv6, FR,  
PSTN, ATM,

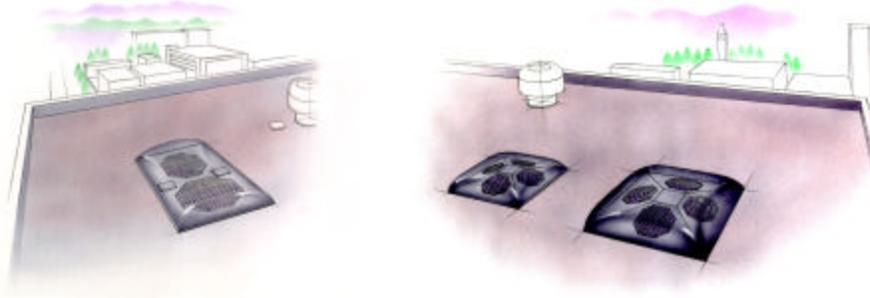
#### Implementation

Mechanical parabolic reflector, mechanically steered arrays, electronically steered arrays

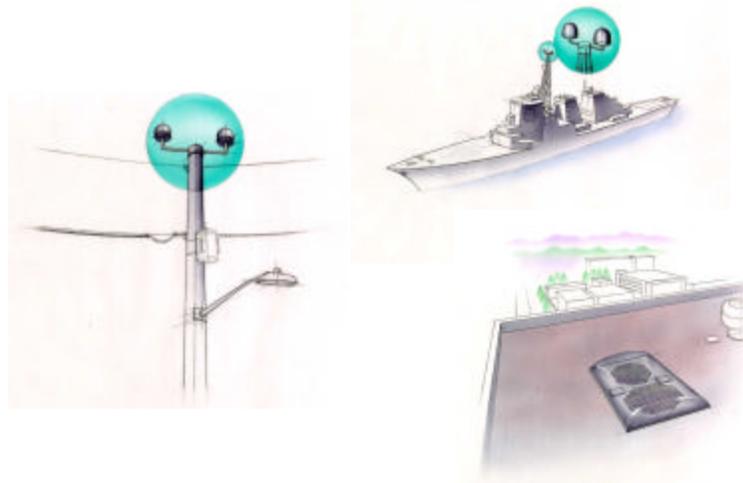
Si/CMOS, SiGe, or GaAs high-speed, wideband modem

Mostly software

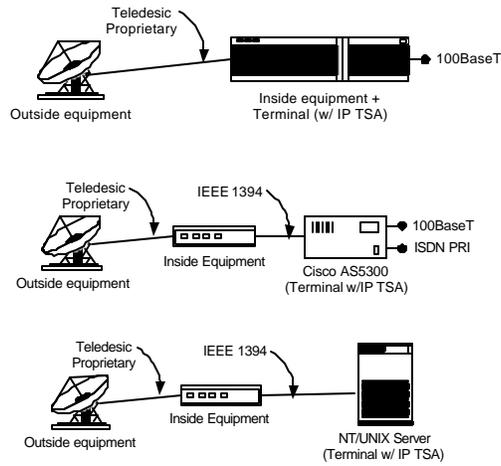
## Phased Array Configuration



## Other Configurations



## Hardware Scenarios



## Conclusions and Recommendations

- Volume Production
- Equipment Testing and Verification
- Physical and Link layer R&D
- Network and higher layers key areas