

Wide Area Multicast Internet Access via Satellite

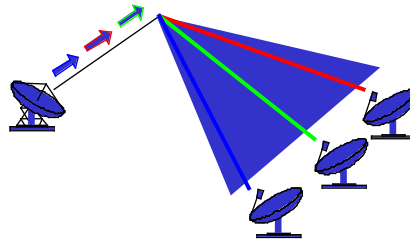
by

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Overview of Presentation

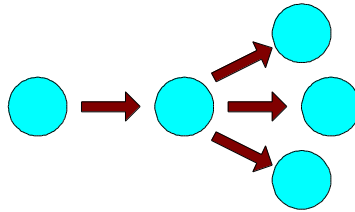
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- Introduction to Multicast**
- Multicast in Wide Area Terrestrial Networks**
- Wide Area Multicast via Satellites**
- Multicast Applications**
- Reliable Multicast Protocols**
- Future Challenges of Satellite Multicast**

Introduction to Multicast - Definition

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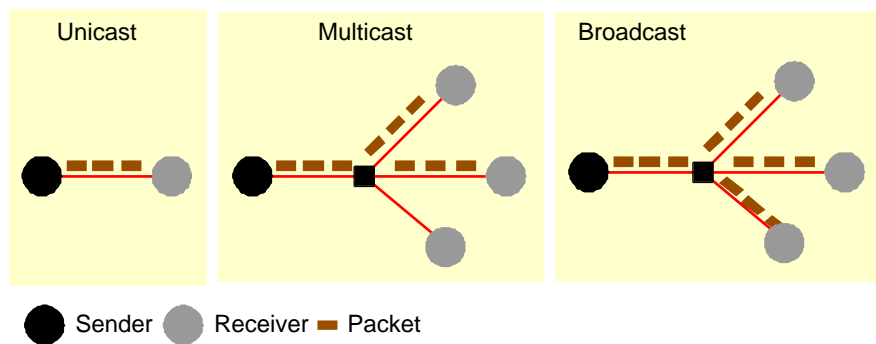
"Multicast [*Deering*] is the act of sending a message to multiple receivers using a *single* local transmit operation"
Ammar & Towsley, SIGCOMM 1997

[Deering, 1991]

PhD Thesis, Stanford University

Unicast, Multicast, Broadcast

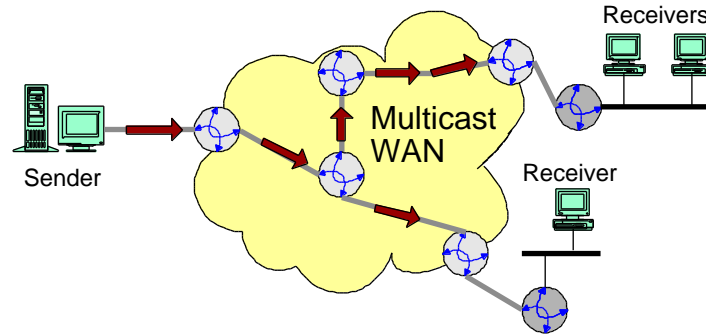
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- Unicast** - One sender to One receiver
- Multicast** - One sender to Many registered receivers
- Broadcast** - One sender to All receivers

Wide Area Terrestrial Multicast - Issues

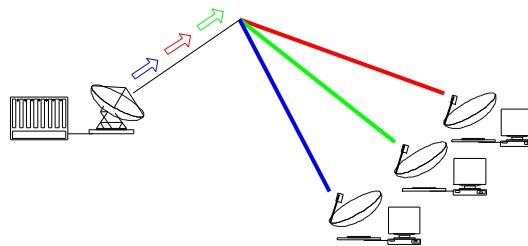
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Large scale deployment (*many routers*) difficult
Traffic *congestion* and *delay* over multiple paths
Inter-domain QoS and CoS support difficult

Multicast Internet Access via Satellites - Why ?

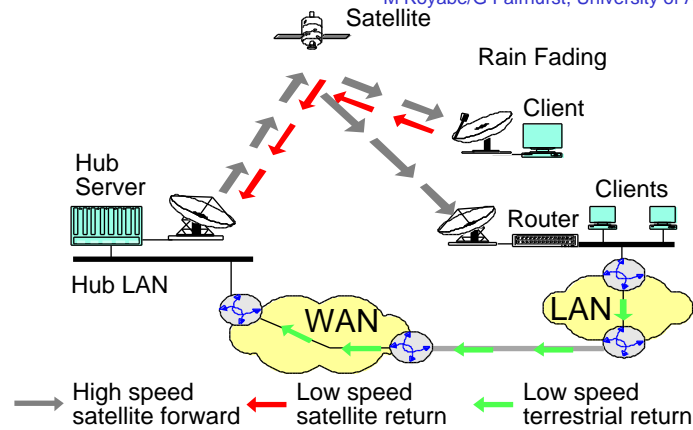
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Broadcast nature (large number of *receivers*)
Abundant *bandwidth* (particularly at higher frequencies)
Increase network *reliability* (minimal *router hops*)
Create new or better *services*
Rapid network *setup*

Wide Area Multicast via Satellite - Inherent Issues

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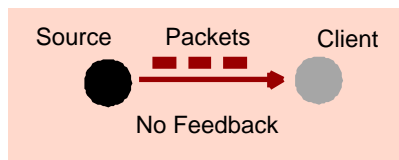
Duplex (forward/return) link capacity needed

Transmission *delay* (~250ms) for GEO

Packet loss due to *fading* (particularly at higher frequencies)

Confirmed & Unconfirmed - Data Delivery Schemes

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Unconfirmed Delivery

Doesn't require *return link*

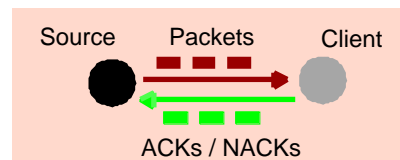
Supports *unlimited receivers*

High *availability link* required

Requires *FEC techniques*

Difficult to maintain *clients*

or *group membership status*



Confirmed Delivery

Requires *return link*

Access links *competitively shared*

Suffers *ACK/NACK implosion*

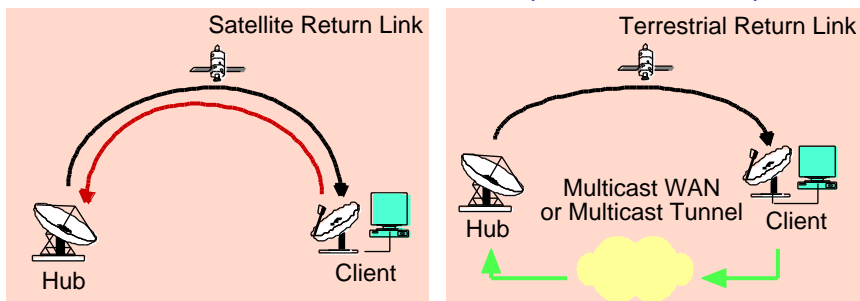
May use *ARQ or FEC/ARQ*

Able to keep *clients/group status*

Limited by *group management*

Return Link Channels - Satellite or Terrestrial ?

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→ Forward Channel
→ Return Channel
 Satellite Return-link

→ Forward Channel
→ Return Channel
 Terrestrial Return-link

Link *asymmetry* fairly high

Return links can be *costly*

Incurs delays (*access/double-hop*)

Link *asymmetry* very high

Return links don't *support* multicast

Return link *guarantee* difficult

Multicast via Satellite - StarBurst MFTP Experience

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Clients *simultaneously* receive file

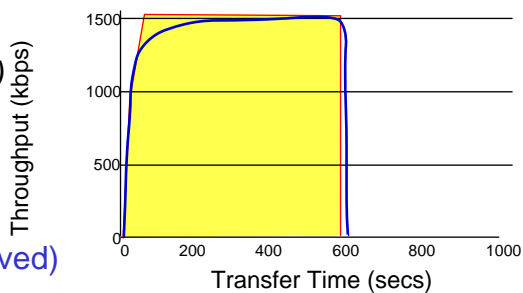
File sent in single *Transfer Phase*

No *Retransmission Phase(s)*
(No packet loss seen)

Data traffic *asymmetry*
(more data sent than received)

— Throughput
— Average Throughput

Client traffic at BER 10^{-10}



Announcement Phase Transfer Phase

Close Phase

— Throughput
— Average Throughput

Multicast via Satellite - StarBurst MFTP Experience

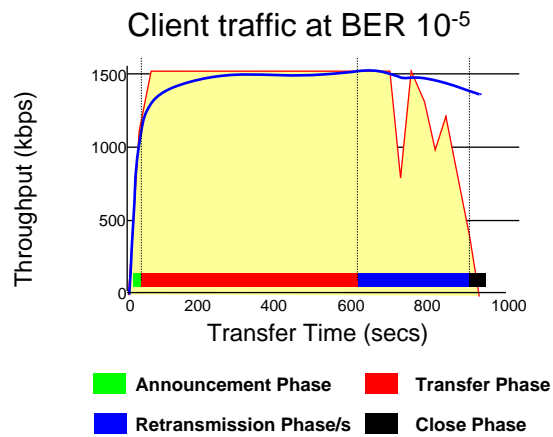
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Not all clients receive whole file in *Transfer Phase*

Packet errors occur (at high bit-error rates)

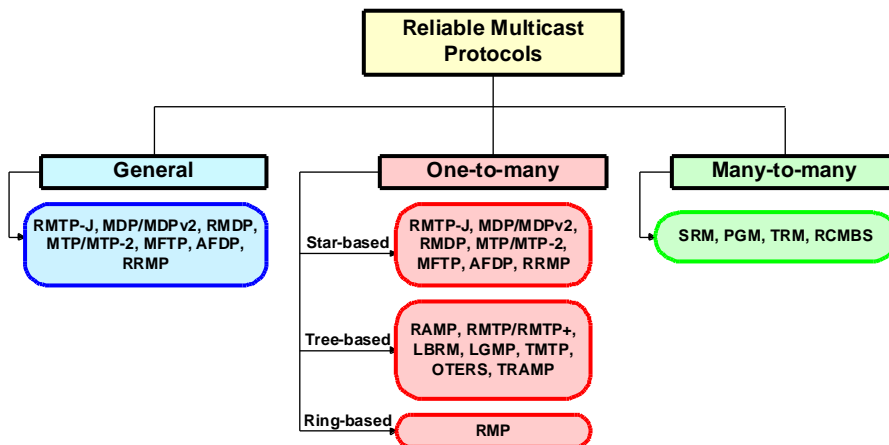
File transfer takes longer (*Retransmission Phase(s)*)

FEC (MFTP/EC) would reduce retransmissions



Reliable Multicast Protocols - Taxonomy

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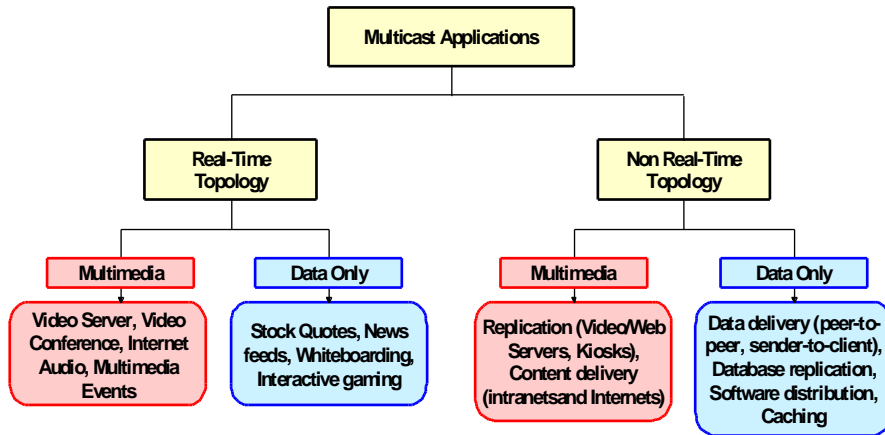


Most protocols are *designed* for specific multicast applications

Not all reliable multicast protocols are *suitable* for satellites

Multicast Applications - Classification

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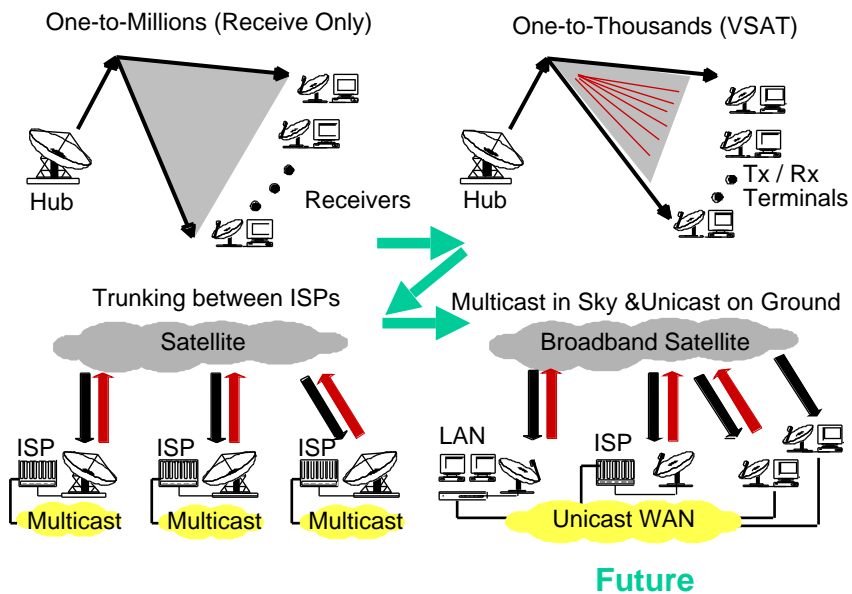
Application via Satellite pioneered by Hughes (Orlando, 1998)

Commercial applications are readily available

High demand of multicast services (increase in satellite use)

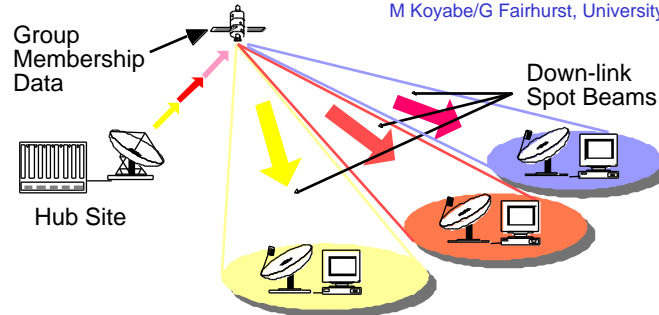
Wide Area Internet Access via Satellite - Development

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Wide Area Internet Multicast via Satellite - Challenges

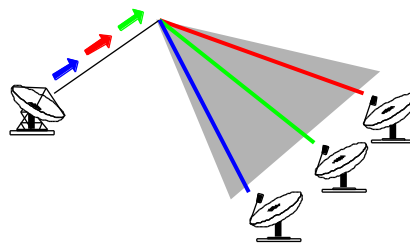
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- Multicast traffic is highly *asymmetric* (favours satellites)
- Terrestrial network return link *does not* support multicast
- Next generation satellites overcome C-, Ku-Band *limitations*
- On-Board Processing (OBP) requires multicast *support*
- Traffic management *essential* for effective QoS/CoS service
- Fading at high frequencies raises *protocol issues*

Conclusions

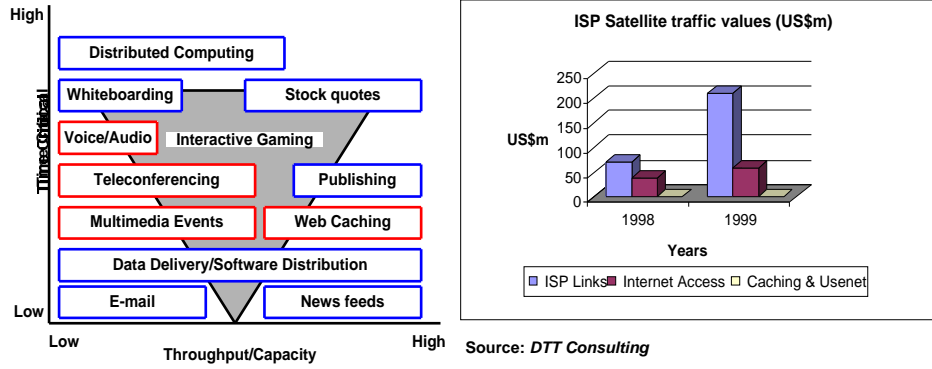
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- Future Wide Area Multicast, may rely on satellite networks
- Multicast traffic asymmetry is well suited to satellite
- Many multicast applications already exist
- Simple QoS and CoS may be managed
- Broadband wide area multicast still faces challenges

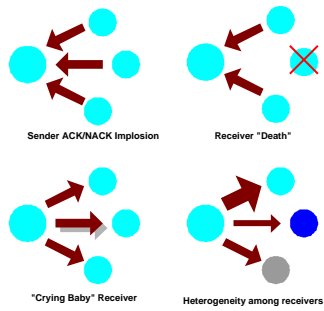
Wide Area Multicast via Satellite - Applications

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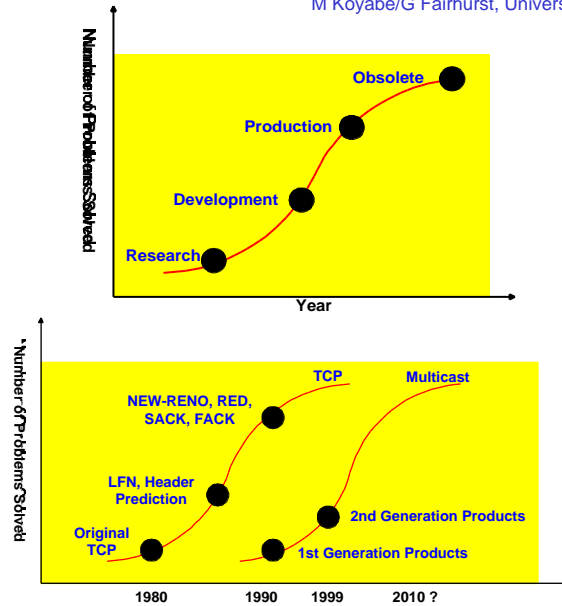
Multicast Protocol Challenges

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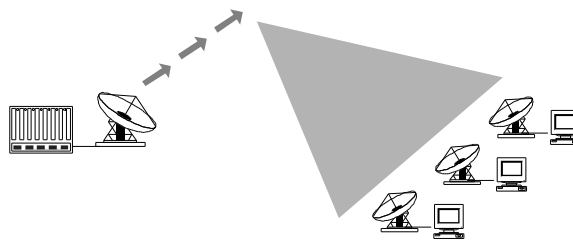
Protocol Life Cycle

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Satellites Networks

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Advantages

A complementary solution

Broadcast nature, enables rapid network setup

Covers wide area providing a global reach

Provides cost advantages

Significant technical and operational advantages

Enables wide range of applications