# Media on Demand Services

Zvonimir Zelenika
Robert Maček
**CARNet RDLab**

# Media on Demand Services

- Welcome to Tutorial
- For start we'll say a word or two about us and CARNet's multimedia activities
- It'll be a long day, so we'd give an overview of all the things we'll do in next five hours
- Let's get going, it's a long day ahead...

# TwoOfUs (tm)

- **Zvonimir Zelenika**
- B.Sc.EE Telecommunications/FER, Zagreb
- CARNet 1996-2002, some networks, mostly multimedia
- TrioMedia 1998-1999, multimedia CDs, multimedia webs
- As of 2000 – Multimedia services in CARNet – CARNet MoD, iTV

# TwoOfUs (tm)

- **Robert Maček**
- Allmost B.Sc.EE (final year)
- Radiocommunications/FER, Zagreb
- As of 2001 – CARNet Multimedia services
- Testing and Implementing of media services and technologies

# Overview of the Tutorial

- Before lunch we'll talk about motivations, services, ideas, applications – some theory, some stories, some examples, some visions
- After lunch we'll talk about technology, solutions, equipment, platforms that we used, tested, analyzed, implemented in CARNet multimedia services

# Where are We?

- Look around and you'll see...
- Nice and Flashy :o)
- This is TeleConferencing Room (TCR) – classroom for:
  - remote lectures (ATM, H.323 videoconf)
  - multimedia labs (small NLE systems)
  - multimedia lectures (audio-video gadgets)
  - showing off (by the Faculty)

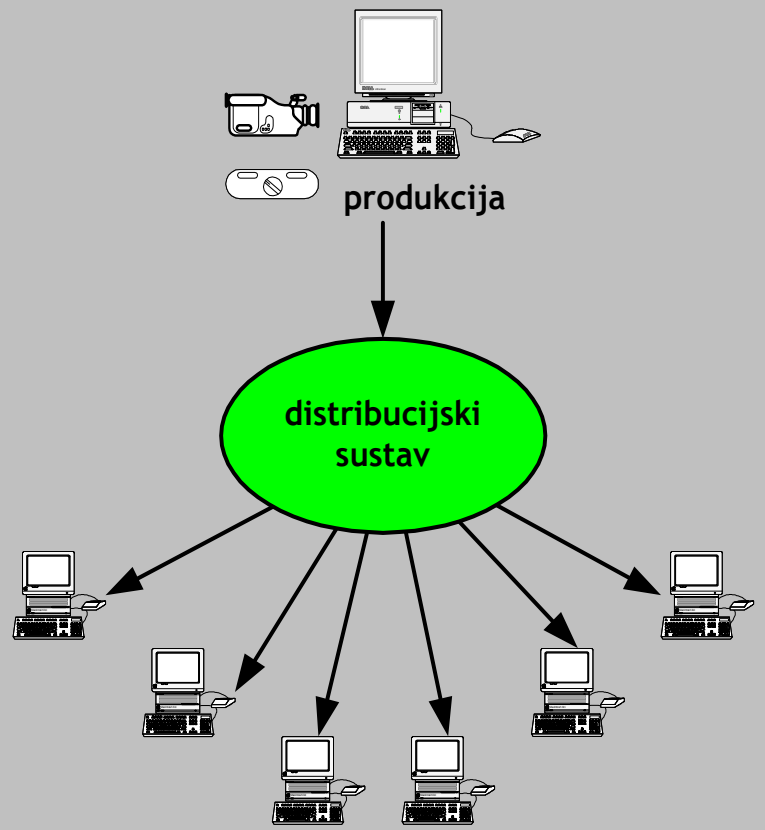
# Visions of multimedia

- Will repeat some things from last year...
- It's evident that network multimedia (hypermedia) services are coming
- Faster computers and networks, cheaper equipment and appliances, emergence of DV standard are bringing down the price-point for hypermedia services
- New multimedia scene is here...

# Creators & Consumers

- Some time ago, creators and consumers were very distant – very few creators and very large and passive audience (TV, Radio, Papers)
- Gap was mostly financial, but also psychological (the way it is)
- Internet enabled (empowered) everyone to create & publish

# (new) multimedia scene

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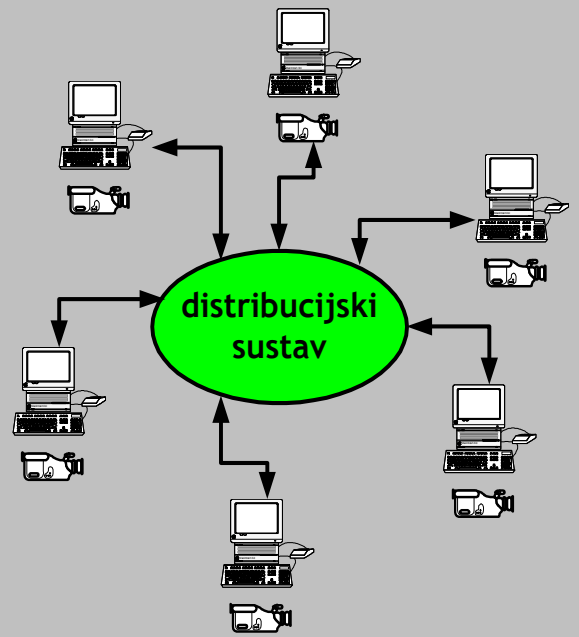


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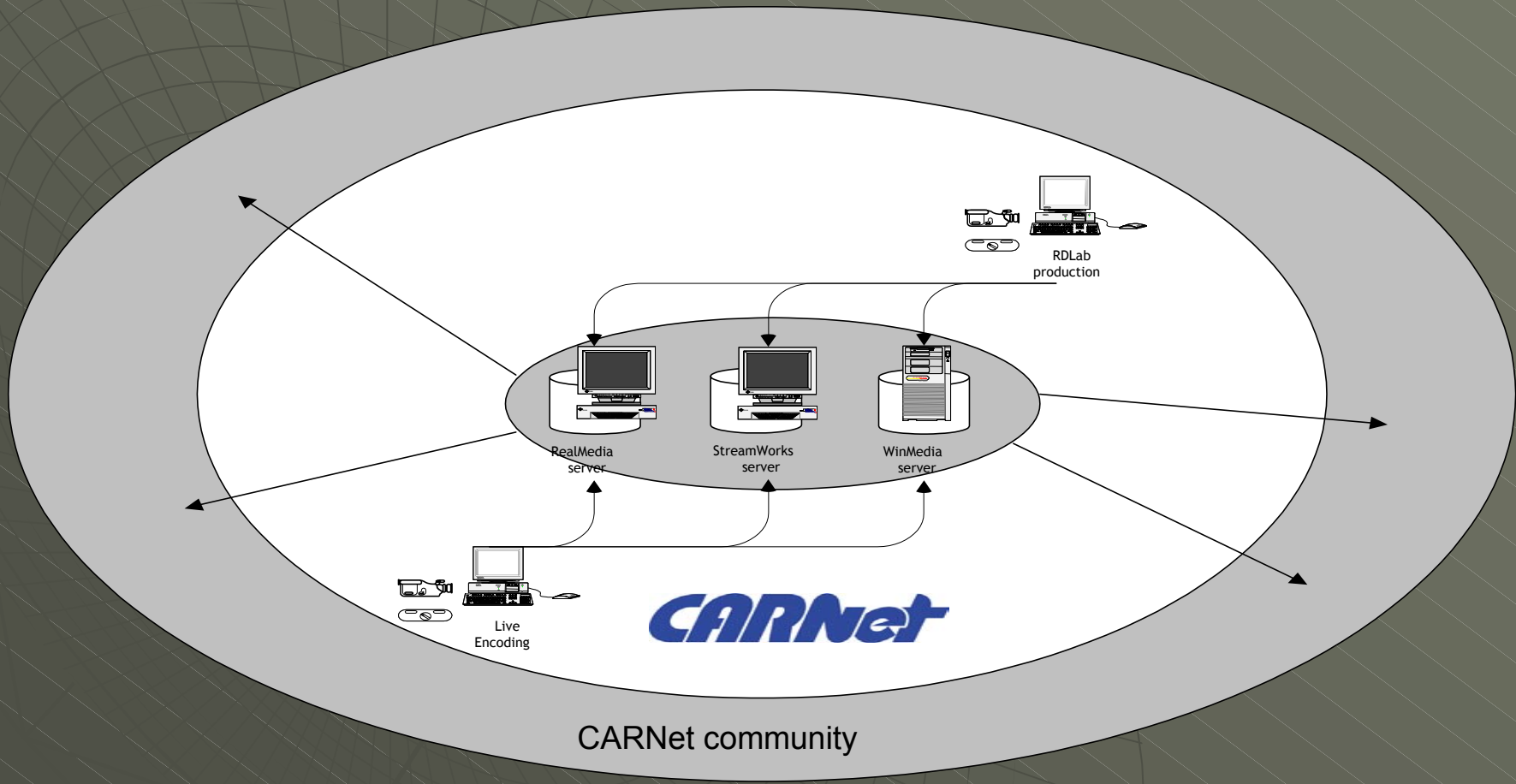
# But to get people talking ...

- Though tools are getting simpler and cheaper, it takes lots of effort to get people producing their own content
- As usual in CARNet's (and other NREN's) history we came to "technology push"
- It's an old story between "Market pull", "Technology push" and NREN trying to persuade community to use the IT

# Multimedia pushing :o)

- Case study: CARNet
- We've been in multimedia since 1994, started streaming in 1997, haven't stopped since :o)
- Since 2000 we started reinventing multimedia in CARNet through several Media on Demand, Internet TV and Videoconferencing projects

# In the begining



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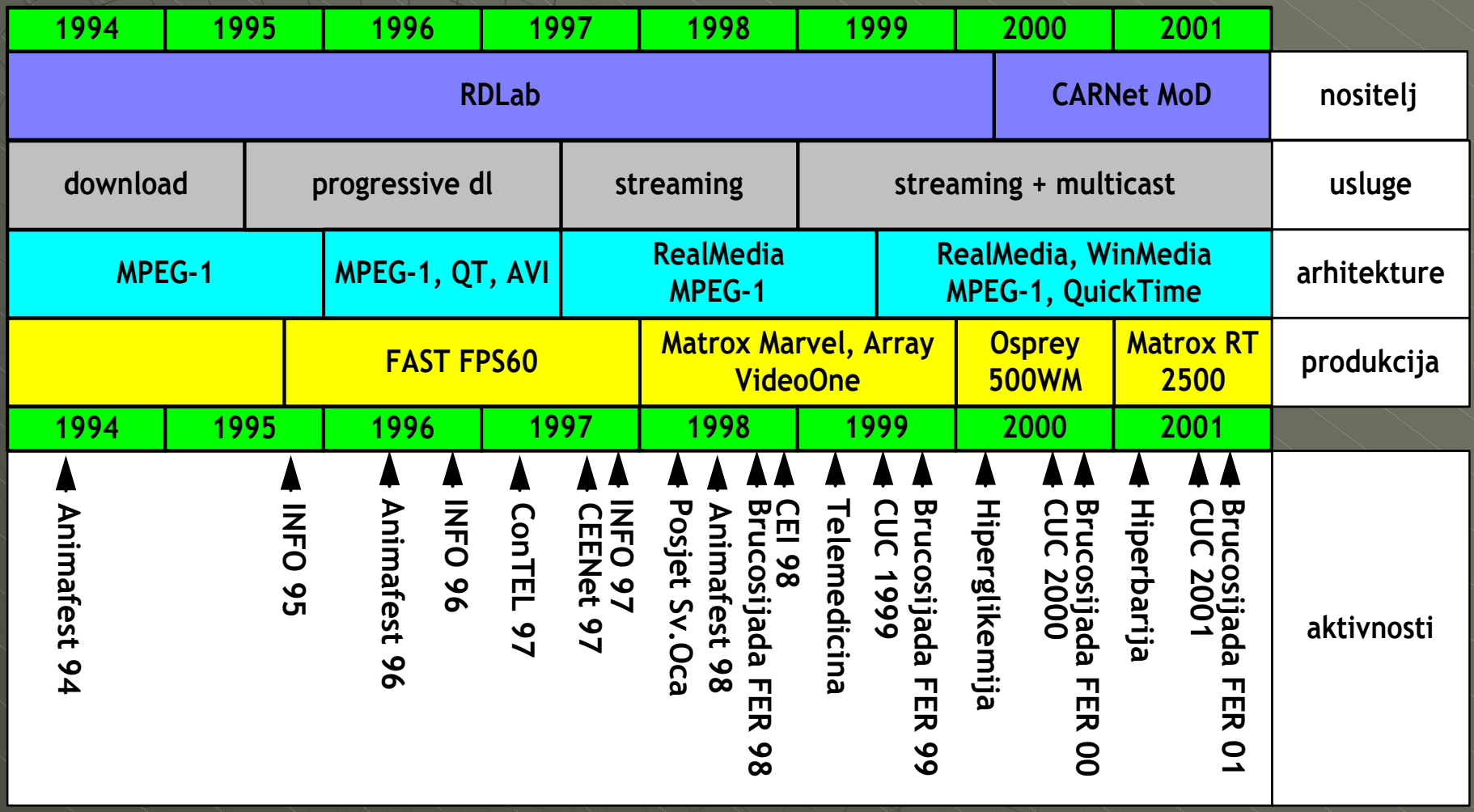
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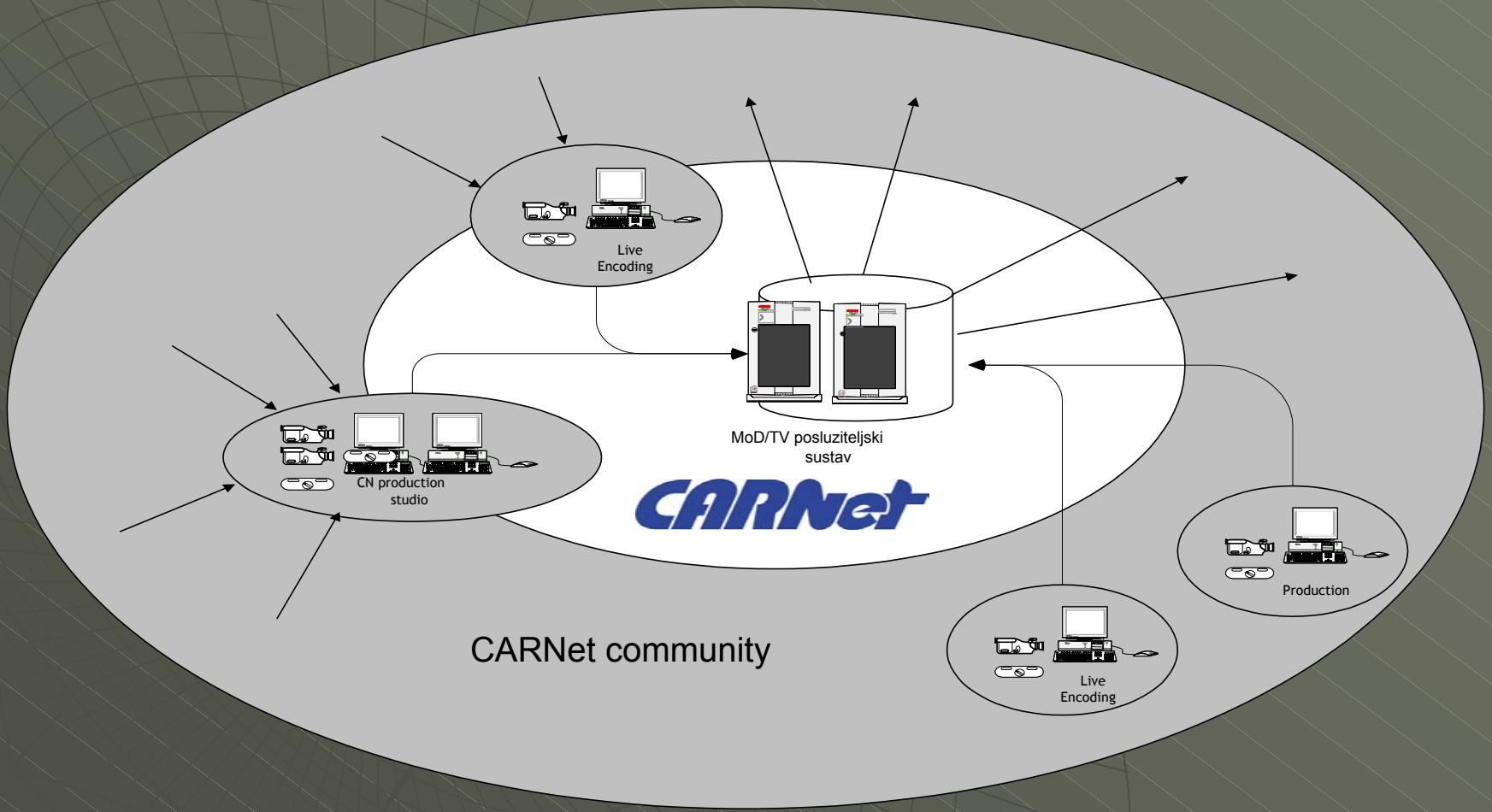
# And now we're here

- We have several services:
  - MoD (production, knowledge, archives)
  - iTV (live streaming)
  - Room VC (H.323 & ATM videoconferencing)
  - Desktop VC (Lotus Sametime, H.323, IPTel)
- We know a lot :o)
- We have the gadgets :o)
- We have and we are looking for partners

# Today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Production
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CARNet community

# Where are we going?

- New CARNet Network is coming (GiCa – Gigabit CARNet)
- Multimedia services are a BIG part of it
- Support for multicast, reservations, security, next-gen IP etc.

- Goal is **CARNET VIDEO NETWORK**

# What should CNVM do?

- Enable everyone in CARNet community to use multimedia in their work/life for education and entertainment
- Provide "multimedia infrastructure" capable of supporting all the wildest dreams
- Provide equipment, tools, solutions, examples, support, training etc.

# multimedia infrastructure

- Worth repeating...
- Building a multimedia-enabled environment takes lots of effort on various levels (network to services)
- Total of all elements required is **multimedia infrastructure**
- It's bit elusive definition, but it's useful to define and dissect it

# mm infra: Network

- Faster connections, especially in access networks (to increase the audience)
- Support for increased traffic in backbone network (usually already there)
- Support for multicast for some services (broadcasts, videoconferencing)
- Traffic shaping and policing, bandwidth reservation and allocation...

# mm infra: Applications

- Internet TV/Radio (pre-recorded program and live broadcasts)
- On Demand delivery (from multimedia archives)
- Offline multimedia (distribution through multimedia CD and DVD)
- **Offer educational, training and entertainment tools and content**

# mm infra: Services

- Running on top of Networks, enabling Applications
  - multimedia archives
  - server systems
  - production systems
  - consulting (support)
  - knowledge base (referral centre)
- NREN as a provider of these services

# Why NREN?

- Way we did it in CARNet, as we couldn't find a partner covering everything from network to applications
- Decided to create and grow our own multimedia competence centre
- Such competence centre would then help others to grow – support creation of new production and competence centers

# Why NREN?

- NREN can cover everything from network infrastructure to application development, or coordinate activities on all those levels
- Also, quite often Institution – NREN – Institution works better then Institution – Institution communication
- This last bit worries me :op

# How NREN?

- Create first competence centre
- Offer production and distribution services
- Gather knowledge and experience
- Share knowledge and consult
- Fund pilot projects within the community
- Provide turnkey solutions for multimedia
- Organize knowledge sharing

# To conclude

- We can expect more and more authors and consumers of multimedia content
- Within academic community, probably NREN is one to support introduction and usage of multimedia
- NREN provides multimedia infrastructure
- CARNet Video Network is our Goal

# Discuss & Break

# Media on Demand Services

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# Possibilities

- We'll go through several How-Tos about creating multimedia solutions and applications
  - Internet Radio/TV station
  - Interactive TV station
  - Home multimedia production
  - Professional multimedia production
  - Computer Aided Learning (CAL, CBT)

# Internet radio station

- Provides radio-station-like experience
- Broadcasts audio content to listeners
- It can be a re-broadcast of existing "traditional" radio station, though "real" Internet radio broadcasts only through the network
- Mostly a result of MP3 revolution

# iRadio: requirements

- Lots of MP3 files, WinAMP player, ShoutCast server, plenty of bandwidth
- All easily obtainable – especially MP3 files
- Licensing is still a shady business, though RIAA has created a licensing scheme for Internet radio stations
- 0.02 cents per song per listener, though rarely or never enforced around here

# Internet TV

- Everything we said for Internet Radio still stands, but this is quite rare as there's very little content and bandwidth requirements are much higher
- Re-broadcasts of existing TV channels is quite common
- Also, quite shady as licensing is concerned

# Interactive TV

- We provide an archive of multimedia content and an interface for end-users
- It's like Video rental where you don't need to get out of the couch
- Content is delivered ONLY for YOU when you want it – ON DEMAND

# interactive TV: requirements

- To achieve required quality we need lots of bandwidth and large archive
- First implementations are pay-per-view (XXX) movie delivery systems
- Usually used in closed environments (Hotels) in analog forms
- Main obstacle for digital open solutions is high bandwidth requirement

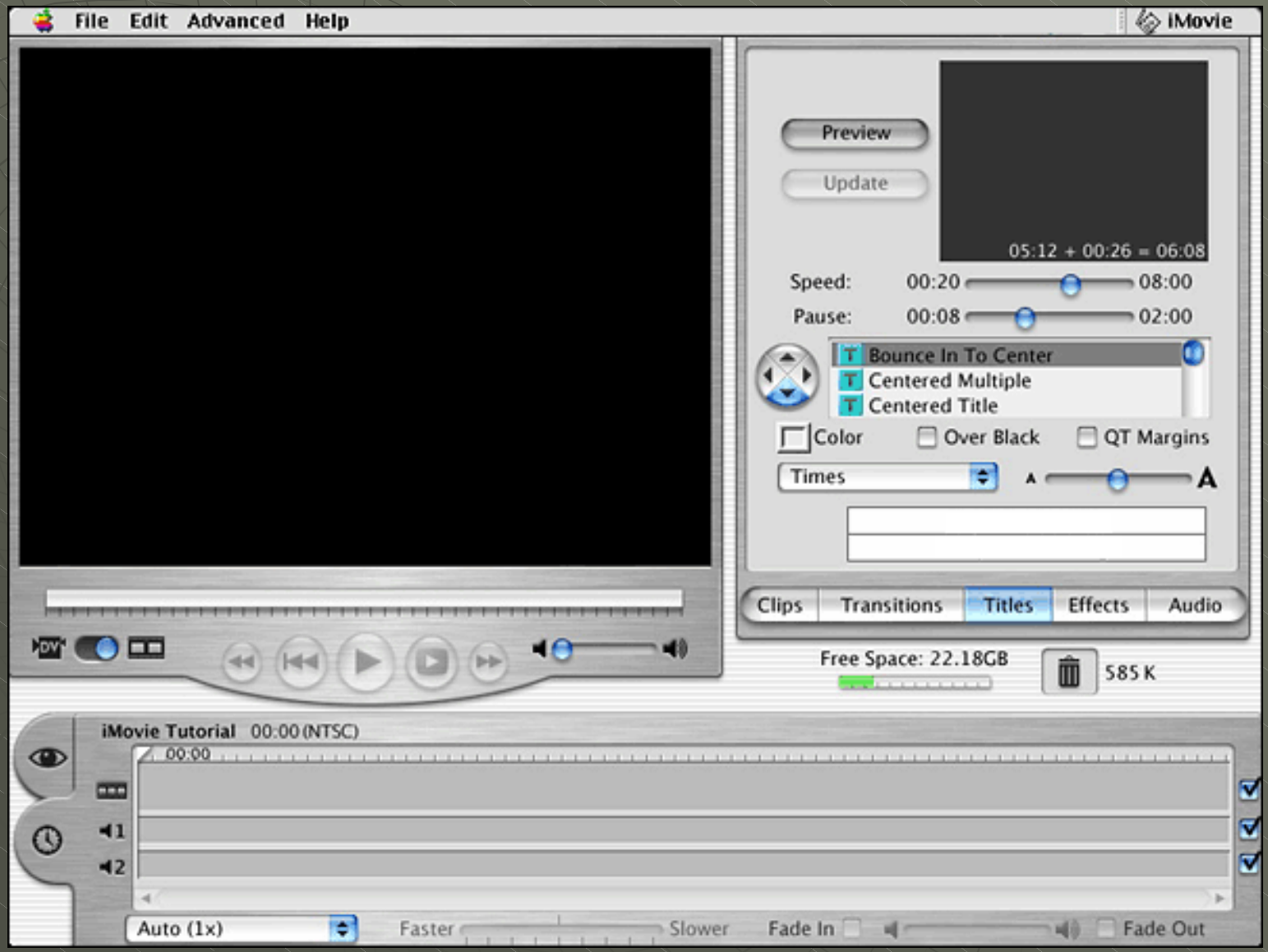
# Home multimedia production

- Or entry-level multimedia production
- DV appliances have made a revolution
- Price point for multimedia production has fallen drastically – 1000€ for computer with FireWire, 500€ for Digital camcorder
- Almost every computer can be equipped with FireWire PCI card (100€)

# Entry-level production

- With little practice everyone can make quite flashy video content
- Editing tools (applications) are quite easy and wizard-like...
- Tools are getting simpler and simpler (Apple iMovie, ULead VideoStudio, Microsoft Movie Maker, Pinnacle Studio)
- Small problems with disk space (as DV takes a lot of it), and European Laws

# Entry-level production



# Professional production

- Event professional NLE (non linear editing) systems can be found at very low price point
- Matrox RT.X100 (RT2500) can be found for 1000€ - provides real-time multi-track DV and MPEG2 editing
- Bit better camcorders (using DVPRO) enable near-BBC quality :o)

# Professional production

# How to output?

- After we recorded and edited our content we have numerous options on how to output and distribute it:
  - back on DV or other digital tape
  - on VHS or other analog tape
  - on CD (VCD) or DVD media
  - on web server (downloadable)
  - on media server (streamable)

# Education solutions

- Computer Based Learning, Computer Aided Learning and several other three-letter abbreviations
- It would be nice to create a easy to use and turnkey solution so everyone can make multimedia lectures
- Nice solution is Microsoft Producer, though we're thinking about our own

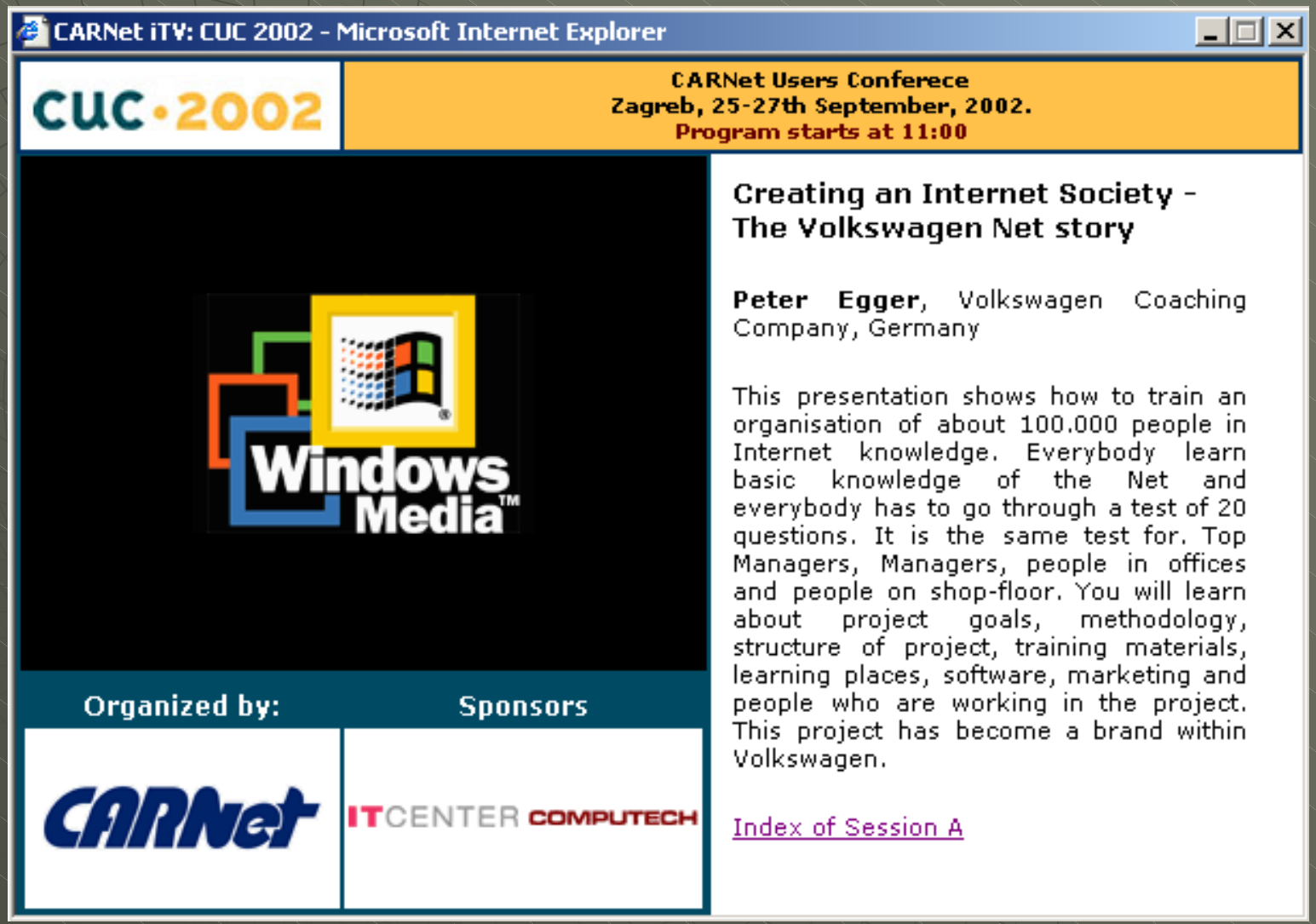
# Education solutions

- We need to integrate:
  - presentation (slides)
  - audio or audio-video content
  - notes, textbooks, manuals
- Technically, not much of an problem, but it is an organizational challenge
- Should look a bit like CUC and CEENET streaming wrappers

# Education solutions

- Currently, no such thing
- Existing courseware tools don't really support anything more than text and pictures
- Maybe, its better to expect results from those developing corporate training solutions, and not academia

# Education solutions



# Discuss & Break

# Media on Demand Services

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# Technical background

- In this part of the tutorial we will give the brief overview of the:
  - Technical multimedia terms
  - Elements of distribution chain
  - Requirements for each element
  - Distribution methods
  - Distribution architecture
  - Distribution modes

# Technical multimedia terms

- **Client**
  multimedia player on the users computer, mostly remote computer, connecting over various packet networks
- **Encoder**
  a computer running software that captures video and audio stream and encodes it into proprietary format using various compression tehniques

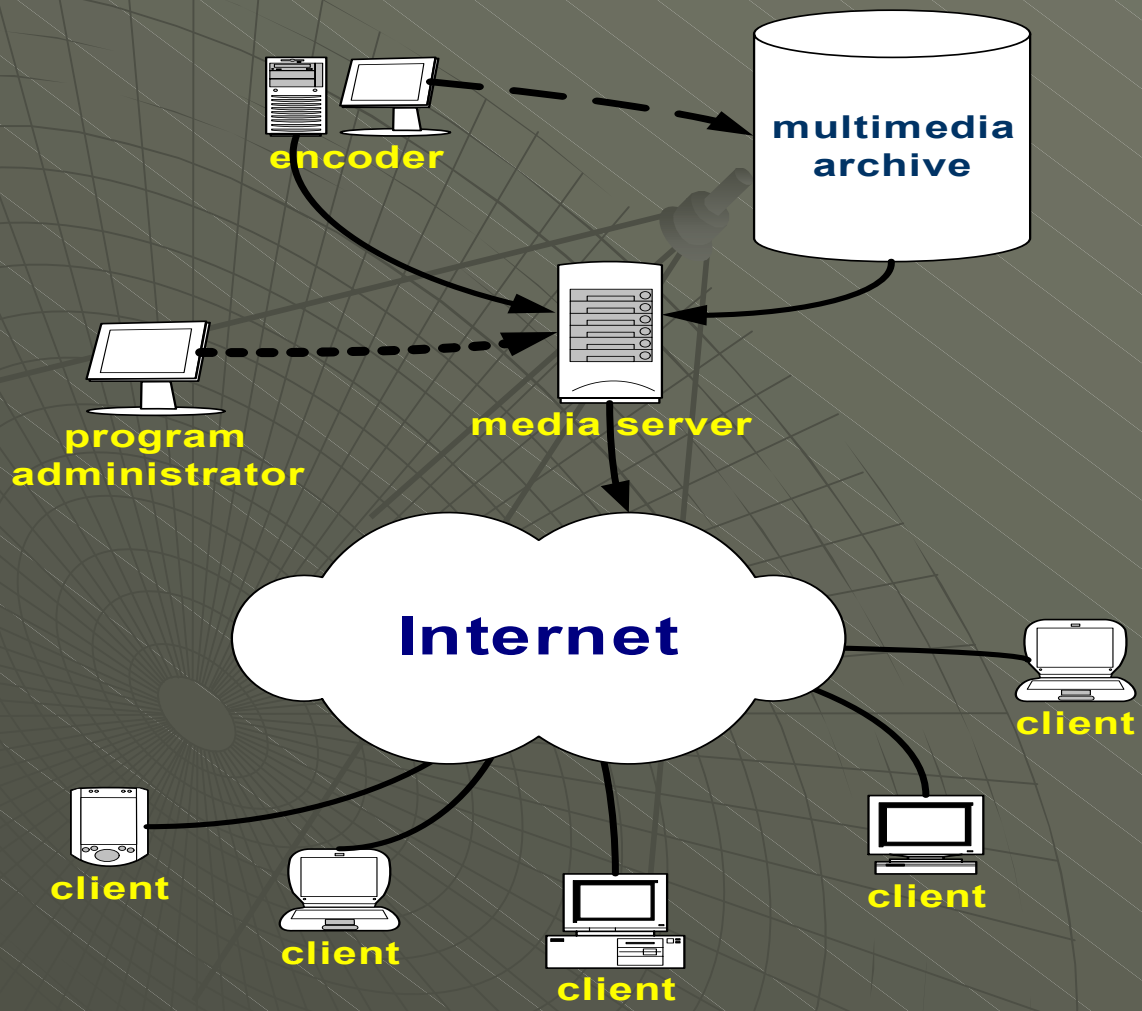
# Technical multimedia terms

- **CODEC**
  COder and DEcoder, in DSP terminology, device for transferring analog signal to digital signal
- **Compression** - process of modification data which reduces the capacity to store it or bandwidth to transmit it
- **Capture card** - a device for capturing real audio and video signal

# Technical multimedia terms

- **Streaming server**
  server dedicated and specialized for delivering multimedia content in synchronized manner
- **NLE**
  NonLinear Editing – process of editing video/audio content with random access to the timeline

# Distribution chain



# Chain - production

- **Input devices**
  cameras, microphones, other video and audio sources (VHS, DV appliances)
- Computer with capture card, used for live streaming
- NLE - used for postproduction and editing of the prerecorded material

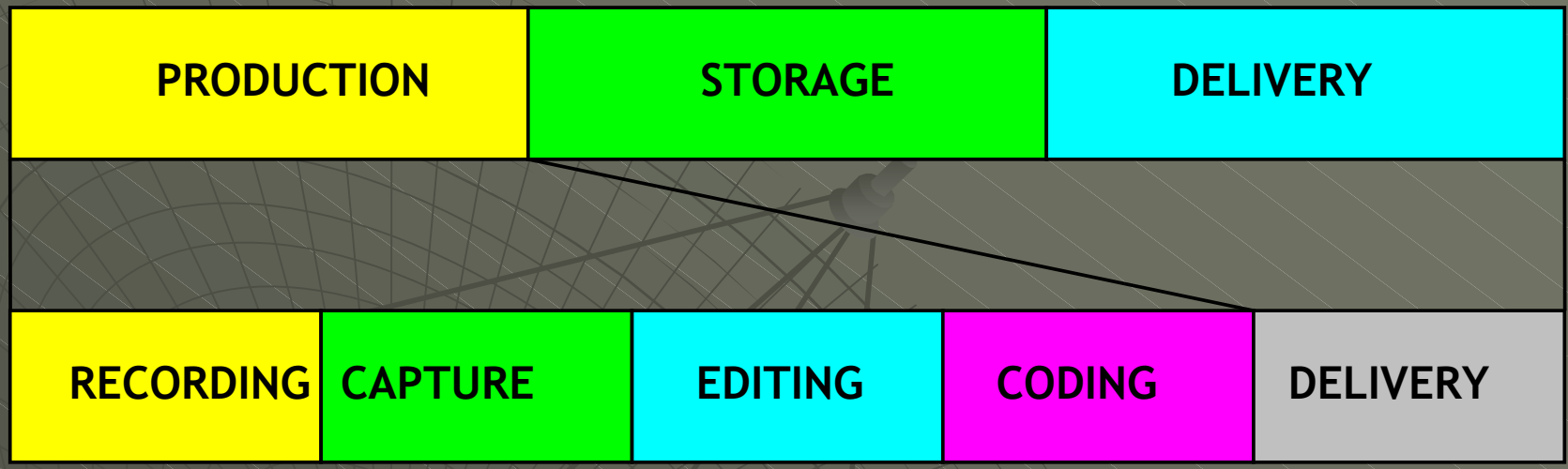
# Chain - client

- The reason for painless implementation of multimedia services is that you already HAVE installed player that you may use
- Players are freely available (at least in basic versions)
- Usually providers use the technology which has biggest installed base

# Chain - server

- Ability to serve live events
- Support for on-demand or program content
- Ability to “split” live streams
- Support for both audio and video data
- Ability to match content to user bandwidth profile (multistream)

# Production workflow




- We identify steps that digital content goes through from its creation to its consummation
- 3 or 5-step model, usually 5-step

# Preparation – step zero

- **Preproduction**
- Preproduction is key element for successful delivery and use of multimedia content
- We have to know purpose of the content, available streaming platform, hardware and software limitations of the both clients and servers

# Production - step one

- **Recording**
- Every production starts with recording of the content either from digital, analog or mixed sources
- Recording of the video signal for streaming has to be performed in manner not usual for conventional recording

# Production - step two

- **Capture**
- Next step is digitalization-coding, even if you have digital source (DV camera) you have to transfer it computer-importing
- In the past it was process of transferring content from analog tapes (VHS)

# Production - step three

- **Editing**
- Mixing can be either live for live broadcasting events or in the studio, some time ago after event ends
- Mixing can be LE or NLE
- With NLE you have the flexibility to erase, add and to modify the content in every way you can imagine

# Production - step four

- **Encoding**
- Final step before distribution of the content is encoding using various compression techniques and various streaming formats
- Encoding of the content for the live streaming has to be done in real time and that puts on great demands for the computer that is doing it

# Production – step five

- **Delivery**
- Storing and delivering content through various methods
- Storage – media archives with content-management systems
- Network – download, streaming
- Offline – CD, VCD, DVD, analog (VHS)

# Delivery methods

- Download-use of standard web server
- Progressive download-the clients are downloading files and while downloading it it’s possible to watch it
- Streaming-widely used nowadays, term used because of constant “stream” of data over the network

# Delivery - download

# Delivery - streaming

# Delivery - unicast

- Every client establishes his own connection to the streaming server
- The method is satisfactory when we need to transfer smaller files, when we can arrange transfer time or when price of transmitting is low

# Delivery - problems

- Problem during distribution is NETWORK
- Internet wasn’t designed for continuous flow of data (streaming) nor for that size of required bandwidth
- Internet was designed to survive The Bomb, not streaming
- Streaming is connection-oriented, high-bandwidth service

# Delivery - problems

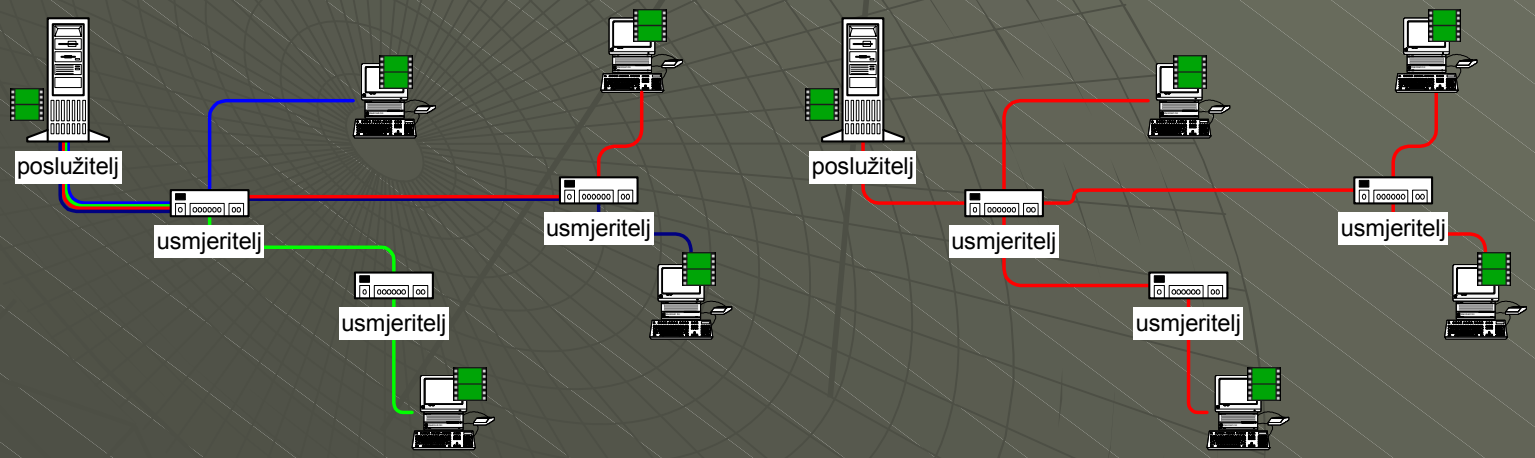
- Constant packet loss (error rates)
- Changing latencies (jitter)
- High packet loss events (burst errors)
- Therefore we are defining network parameters:
  - throughput
  - transit delay
  - delay variation
  - error rate

# Delivery - multicast

- One way of upgrading multimedia services
- The clients are not connecting to the server and pulling their own stream
- The multiplication of the stream is done by multicast-enabled routers
- The network has to be multicast enabled
- Basically, NETWORK is broadcasting

# Delivery – unicast vs multicast

- unicast – every client receives its own stream, clients receive separate streams
- multicast – network multiplies the streams, clients join/leave groups receiving the stream



# Discuss & Break

# Media on Demand Services

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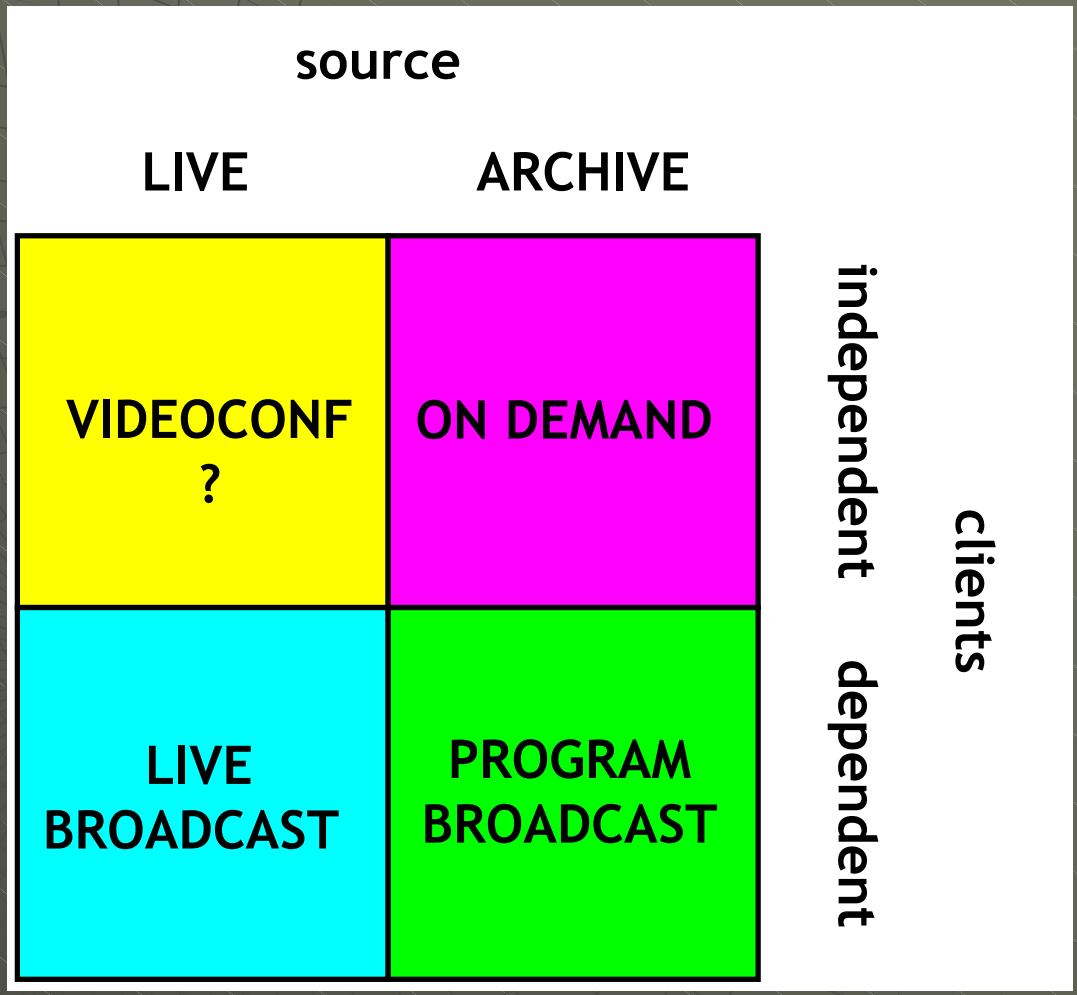
# Application types

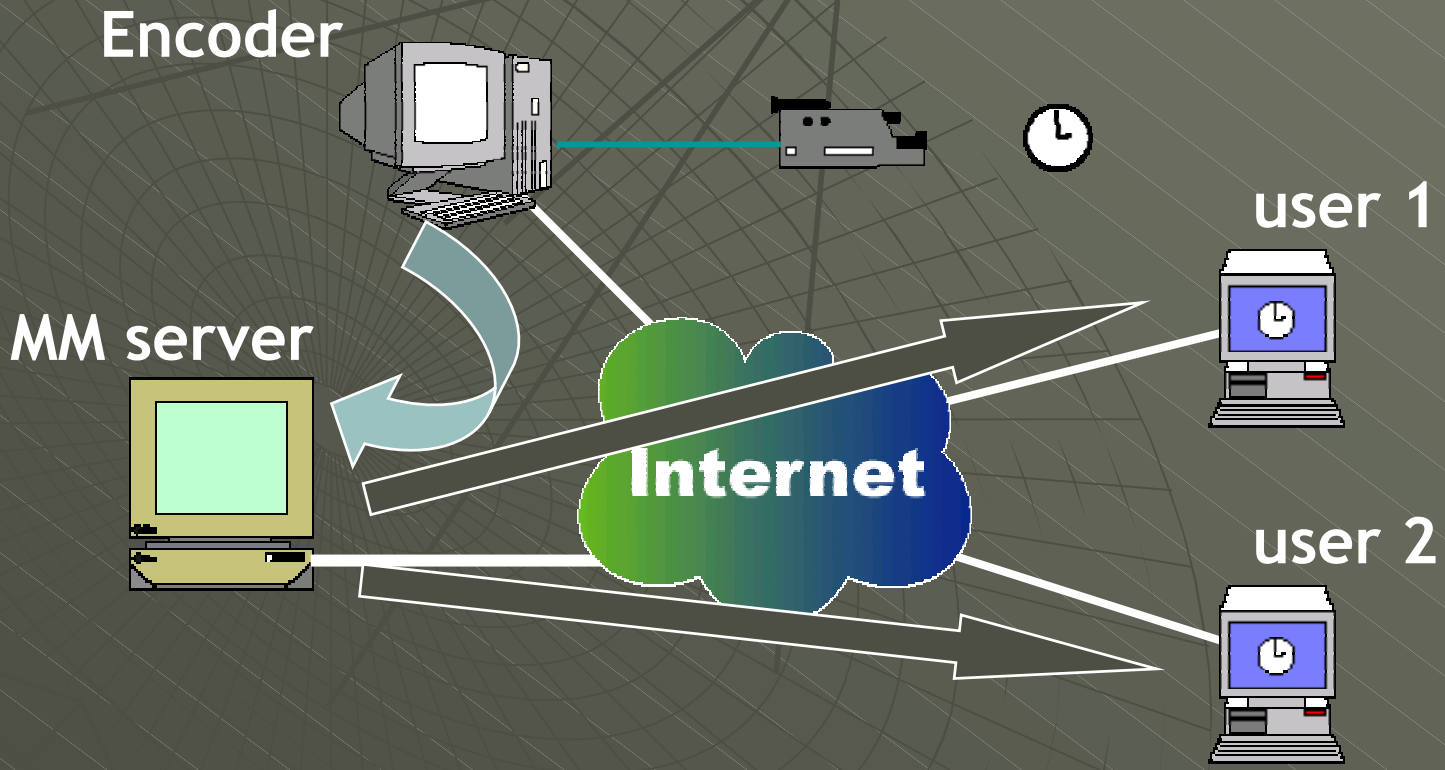
- We define them through two variables: whether the source is LIVE or ARCHIVED, and if the clients are time DEPENDENT or INDEPENDENT
- We create a 2x2 matrix with three important and one useless field :o)
- This way we define possible multimedia services

# Applications



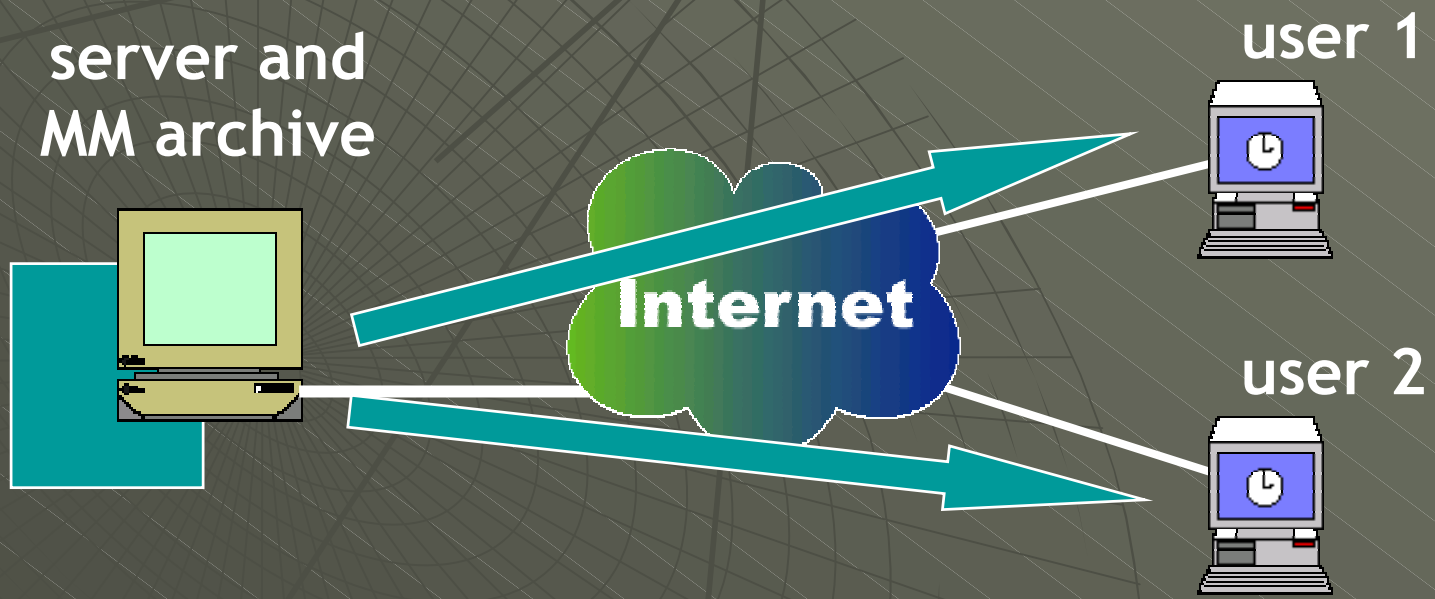
# Live Broadcast

- Encoder records live event which Server multiplies and broadcasts to users



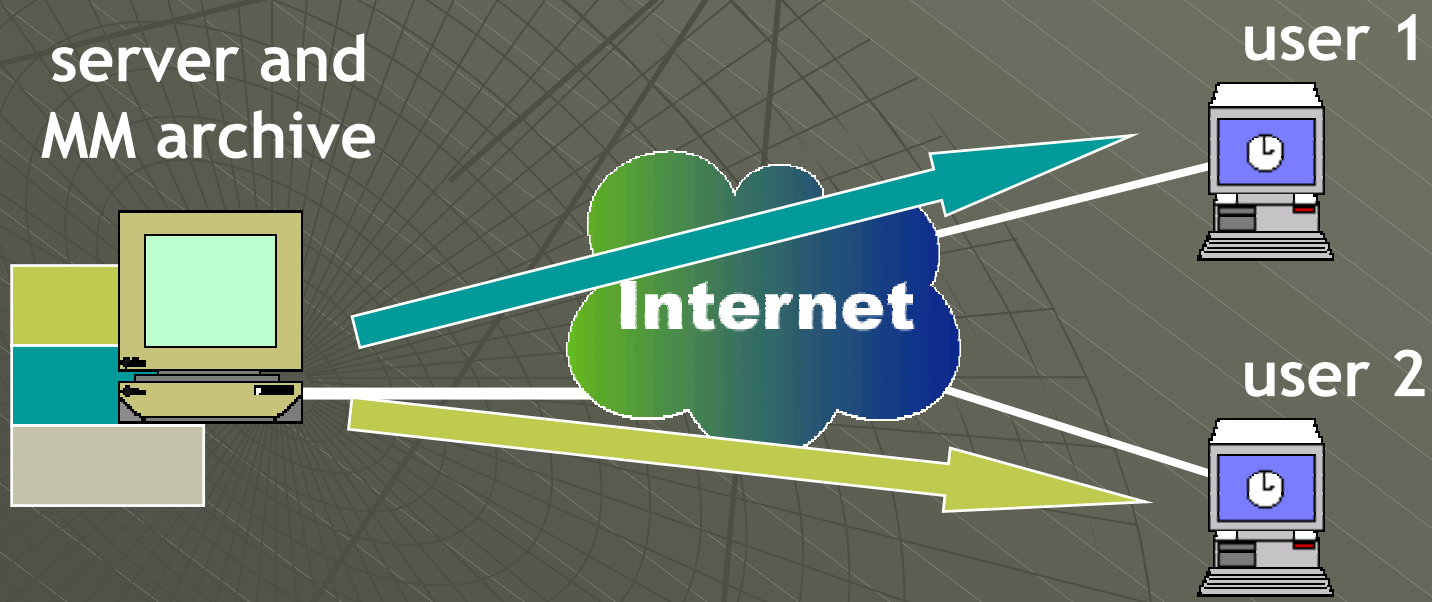
# Program Broadcast

- We create "playlist" and server broadcasts it to all clients



# On Demand Delivery

- Users select content from the archive which is then delivered on user demand



# And how we do it?

- Now we'll do an overview of CARNet's activities in multimedia and how do we do it...
- Since 2000 we spent lots of effort (and money) on creation of multimedia competence centre in CARNet RDLab
- We're ready to spend much more (both effort and money)

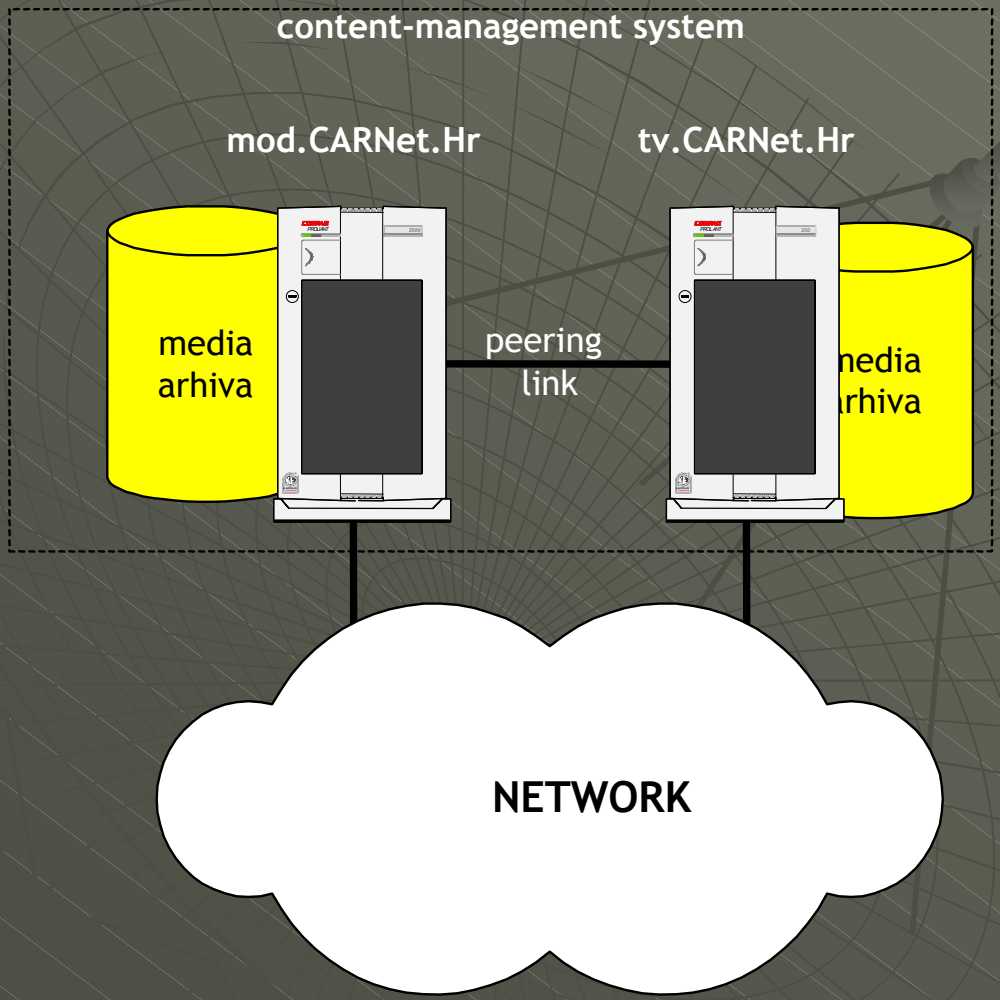
# What we have :o)

- MoD/TV Server system
- MoD Production studio
- MoD Multimedia archive
- CARNet iTV server
- Multimedia Referral Centre
- Live streaming coverage teams (four)

# MoD/TV Server

- Two P3/667 Compaq Proliant servers
- GNU/Linux Debian 2.2
  - content management, content storage (170GB), Darwin Streaming Server, RealMedia Server, Xing StreamWorks Server
- Windows .NET Server 2003 Beta
  - Windows Media Services 9, content-management, application development, content storage (150GB)

# MoD/TV Server




# MoD/TV Server - capabilities

- Streaming of all common formats
- Large storage space
- Content management system (XML)
- High outgoing bandwidth (on the CARNet core) – though maximum load was 25Mbps on one test
- Platform for creation of multimedia applications

# MoD/TV server - demo

# Discuss & Break

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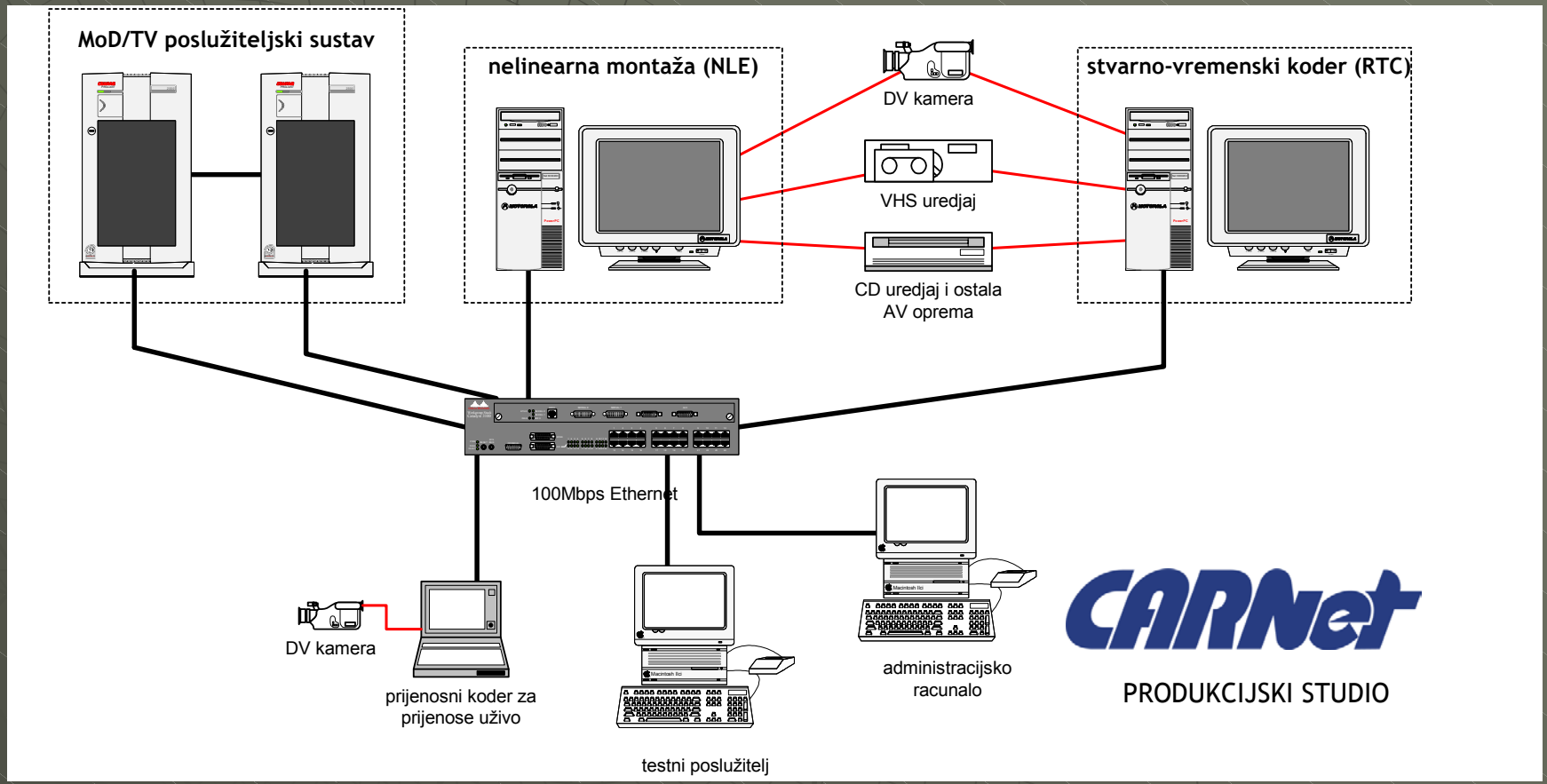
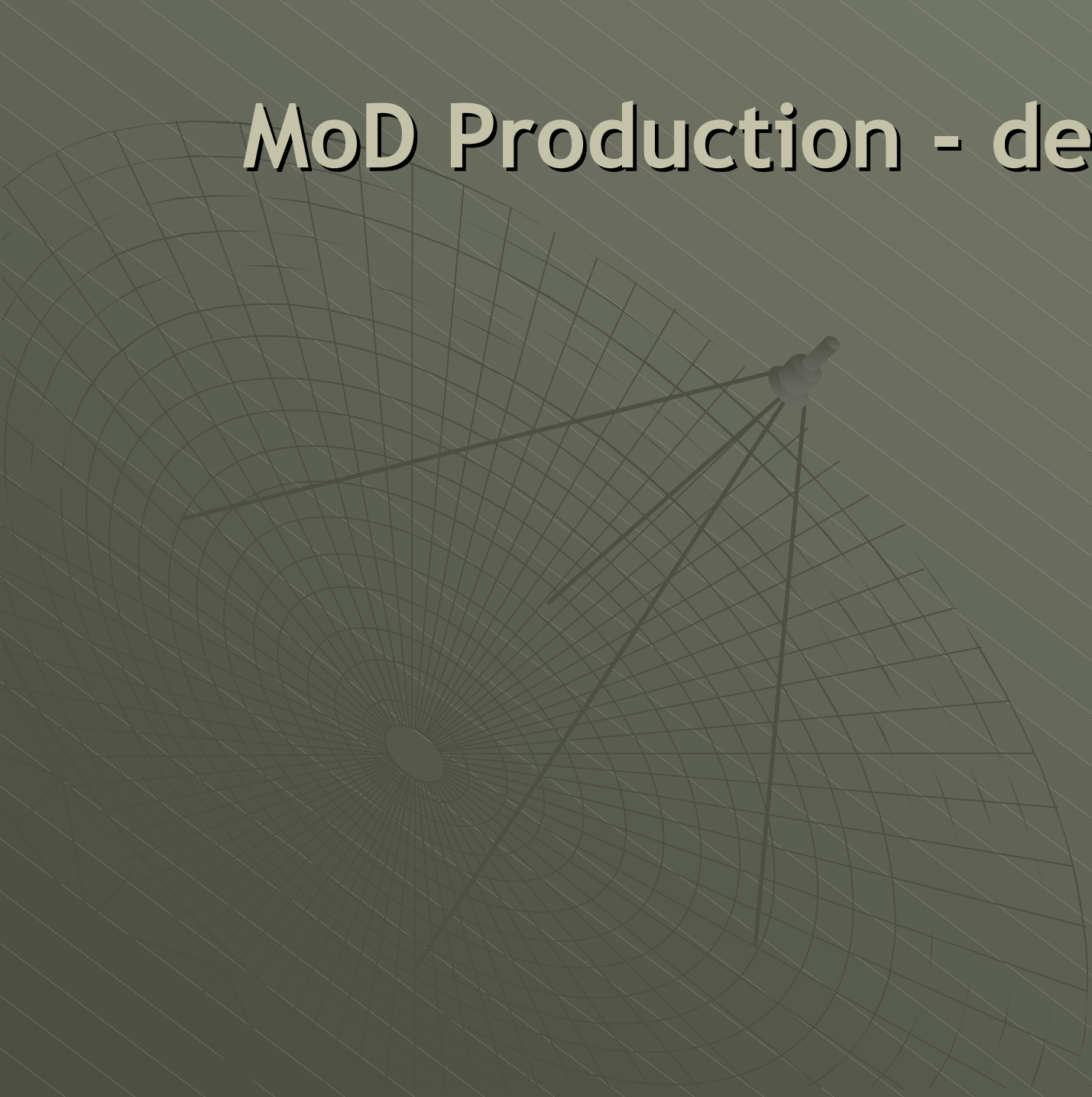
# MoD Production Studio

- P4@1400 with Matrox RT2500 NLE
- P4@1400 with Osprey WM500
- VHS, S-VHS, CD appliances
- analog audio and video mixers
- Two Hi8, one DV cameras
- Soon GBit Ethernet, creation of SAN between production systems and servers
- Soon another Matrox RT X.100 NLE, DVD

# MoD Production Studio



# MoD Production - demo



# Live Streaming coverage

- Currently four sets of equipment for covering (broadcasting) Live events
- Two P4@1400 and two P4@1800
- Audio and video equipment (remote controlled cameras)
- Currently using Windows Media Encoder 7 and WM V8 codecs as default
- Using two sets now on CUC

# Live Streaming coverage

- Recently we started using Windows XP
- Testing WM Series 9 Encoders
- Remote control of encoders and cameras
- Remote control of server

- small demo

# Live Streaming - demo

# MoD multimedia archive

- cca 300GB of storage space (RAID)
- content-management system with XML schemes describing multimedia content
- Open to content from other organizations and institutions
- http://mod.CARNet.Hr/hr/

# MoD archive - demo

# CARNet iTV

- Providing access to CARNet Internet TV programs – now we have CNTV1, 2 and 3
- Starting as of today, though content is still pretty scarce
- Actually should provide others within CARNet community with streaming services (Radio 5+)
- http://tv.CARNet.Hr/

# CARNet iTV – demo

# Referral Centre

- Referral centre for multimedia
- Provides information and instructions about multimedia technologies and solutions
- We partner with other organizations to provide us with  content
- Students writing their seminar papers and thesis papers

# Referral centre

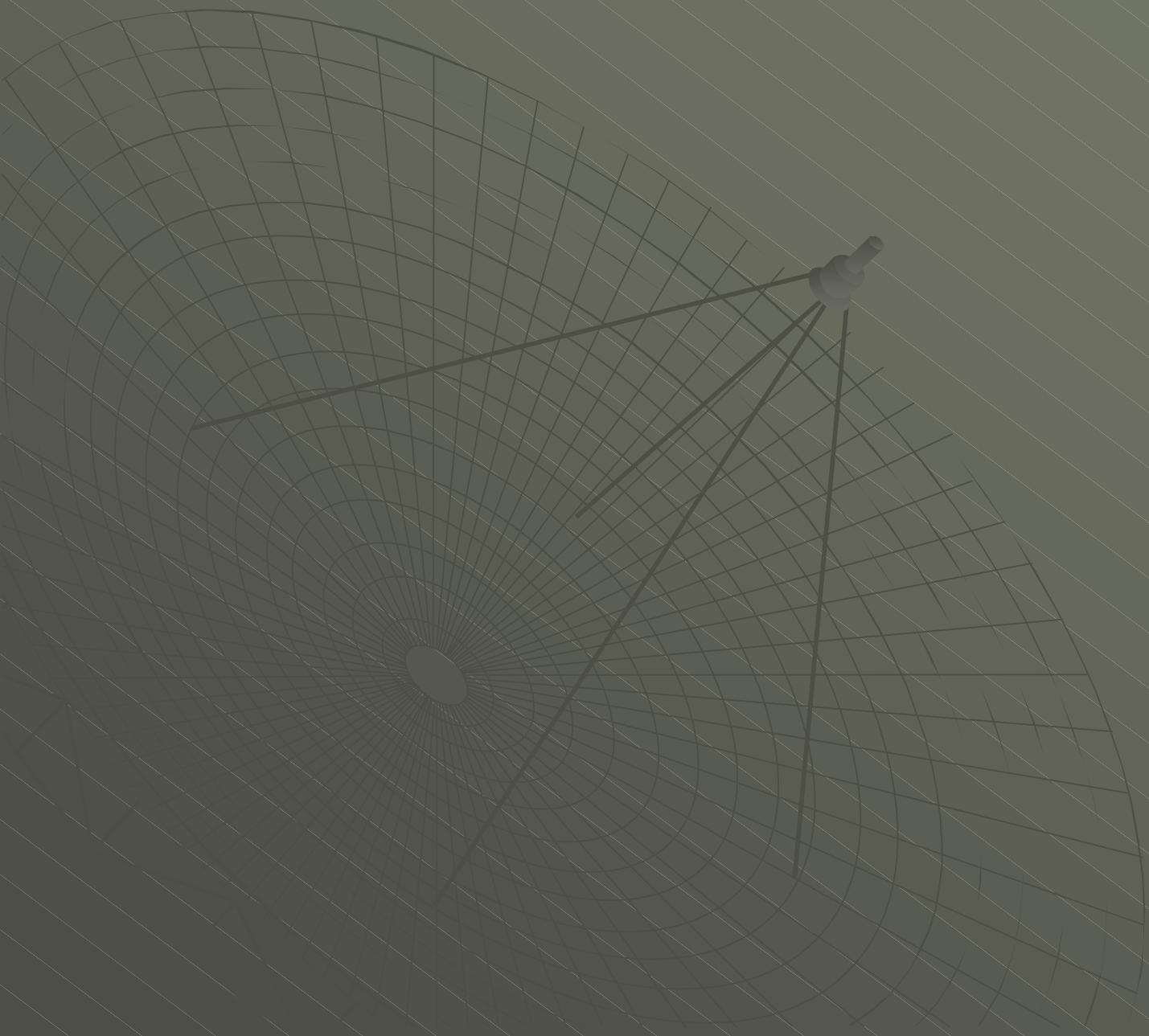
- Spreading towards providing support for teachers for using multimedia in education process
- Should provide community support for multimedia (Forums, FAQs etc.)
- Test results from research and testing performed in CARNet RDLab
- http://mod.CARNet.Hr/docs/

# Future development

- Multimedia is one of three major interests of CARNet Research and Development Laboratory
- We're testing basically everything new coming out in multimedia-scape
- Usually means running beta versions of encoders, servers, players
- Development of multimedia applications

# Recent Testing

- Regular codec testing (with metrics for video quality)
- GPL solutions – Darwin Streaming Server, IceCast, oggVorbis
- Windows Media Services 9
- QuickTime 6 / DSS4
- RealNetworks Helix (in the queue)



# Finished