# Vision on Future Content Networks

## A Networks and Media joint venture

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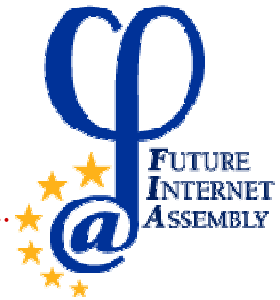
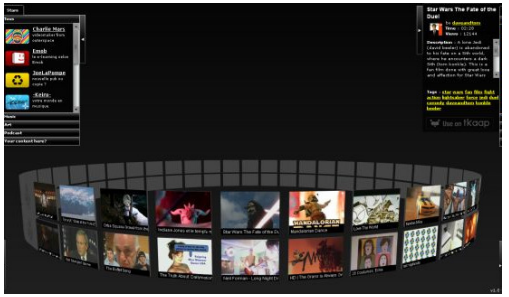


# Content on the Net

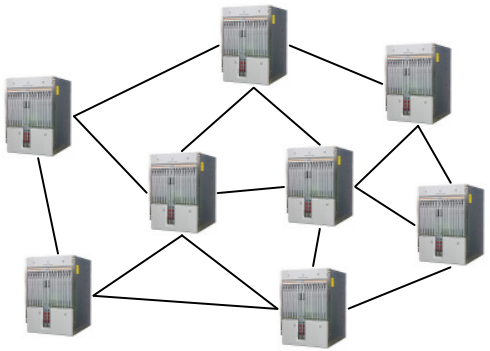
- 90% of the traffic on the Net is content related – still just a bitstream
- Audio-visual content invades the Net in all its forms
- New 3D, free viewpoint and immersive formats are being developed
- User generated content drives the Web 2.0
- P2P has evolved from „sharing“ music to generally distributing content




# How to See Content from the Network?

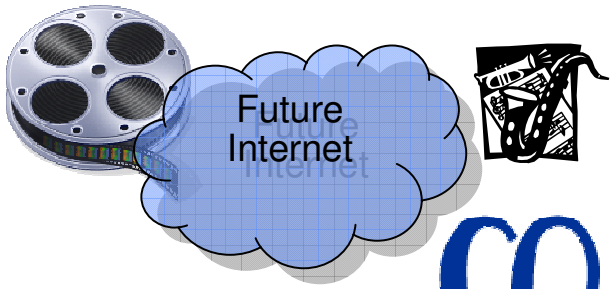
- We got WWW, overlays and CDNs – are we done with content support in the network?
- **Content today is a hostage of location, application and access**

Today's Internet
Focus on *nodes*



Evolution

Future
Content
Network
Focus on *information*



# Limitations Imposed by our Way of Networking Content

- No *persistent content naming scheme*
  - URLs and IPs overloaded with locator and identifier functionality
    - changing it's name („404 file not found" errors)
    - HTTP redirects require ... increase *traffic* & *latency*
  - Low latency, world-wide scalable *Name Resolution* ...

http://www.ft.com/cms/84d2eba2-2a26-11dc-9208-000b5df10621.html?_i_referralObject=954930602&fromSearch=n

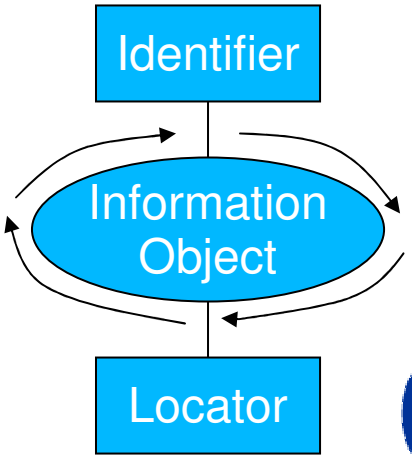
- No consistent *representation of content*
  - Different *encodings* (e.g., mp3, wav) worsen problem
- No efficient built-in content *distribution* and *adaptation*
  - Caching and transcoding left to applications, not built into network mechanisms
  - No "anycast": e.g., find and get "*nearest*" copy
  - Problems like *Flash-Crowd Effect*
- No inherent protection from Spam and *Denial of Service*
  - Receiver always has to receive
- No content centric *Security*
  - Mainly based on *securing channels* (encryption) and *trusting servers* (authentication)
  - Can't trust the content itself

# A Future Content Network

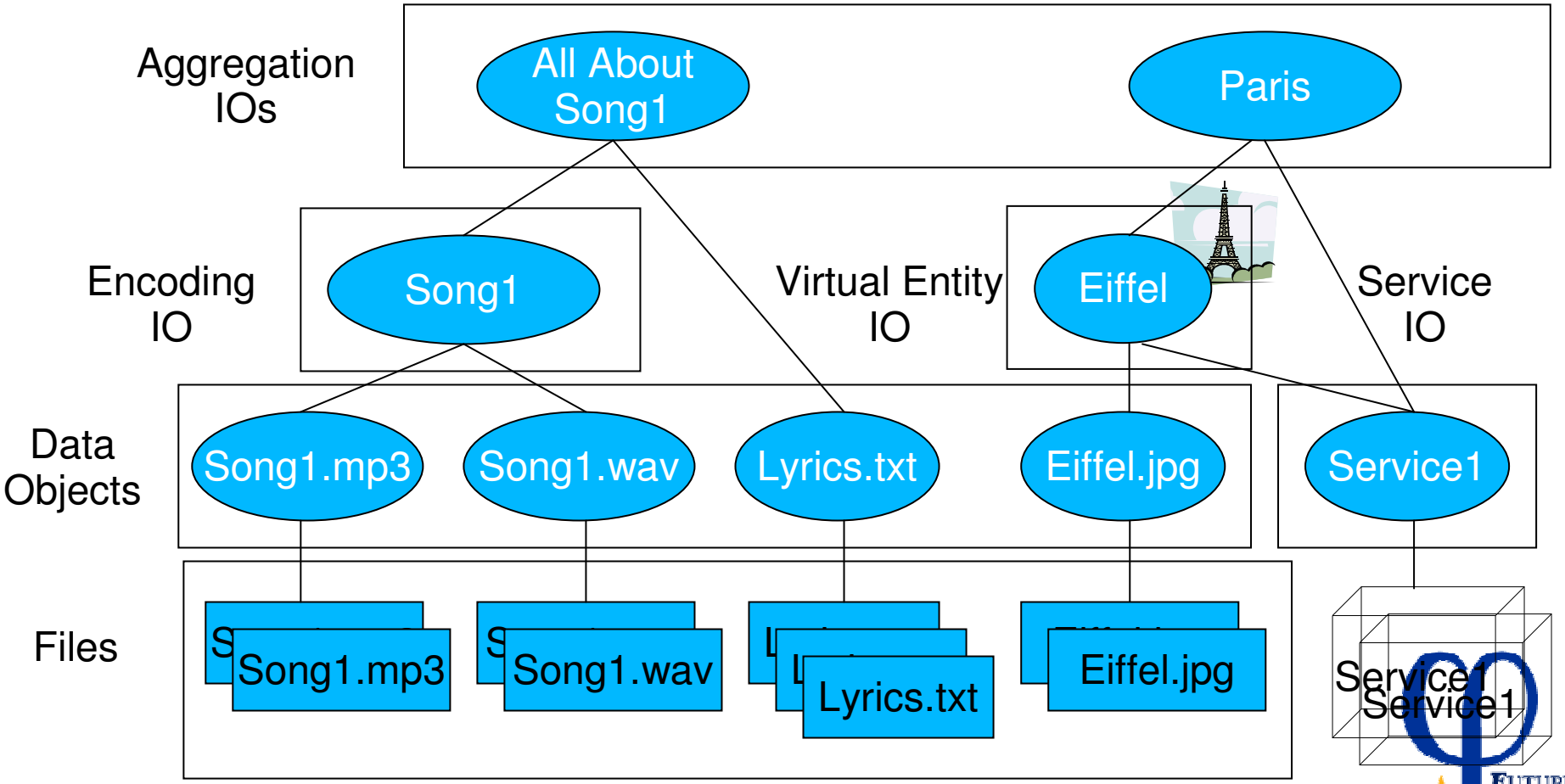
- We are used to think a network consisting of nodes (end + forwarding) and links
- What if we start to network the information we are looking for...
- ...and chose the best transport based on the content, the device and physical media?
- Imagine this content network enhanced by real world interfaces and new media formats...
- ...produced and consumed in a dynamic marketplace
- **Could be the ingredients of a new success story**

# How to See Content in the Future Internet

- Identifiers refer to information/data, not hosts!
- Step 1: *identifier/locator split*
- Step 2: introduction of **Information Objects** *-> information-centric*
- Information Objects (IOs)
  - Representation of semantics
    - A file (e.g., a text, movie, song)
    - A service
    - A stream
    - A real-world object (e.g., a book, person)
  - Contains no “bit-level” content
  - Can contain metadata
  - Can link and aggregate information



# Example of Information Objects

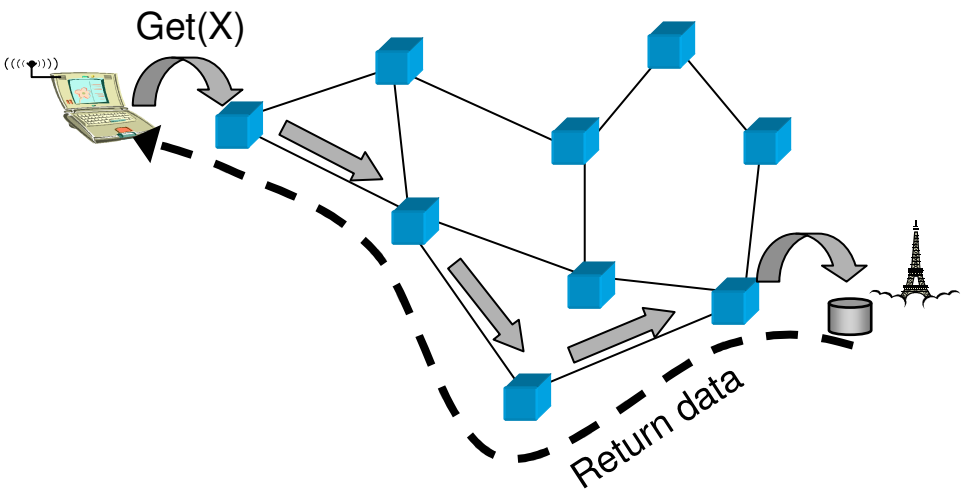


# The Benefits

- **Users**: Content effortless available on any device, using any access
  - Users may easily divert, adapt and prioritize the content they want
  - And submit content at any point
- **Content application providers**: concentrate on their core business: production, aggregation, classification and marketing of content
  - Content that sells is finding its way to users
  - Support of new formats easily migrates into the network
- **Network service providers**: get more options and a better way to handle traffic
  - Self-scalability of popular content
  - Unification of mobility, security and QoS
  - Reduces irrelevant traffic (format adaptation and transport optimisation)
  - *Improves network performance while reducing operating costs* — increases efficiency by at least three orders of magnitude. (claim made by Van Jacobson)

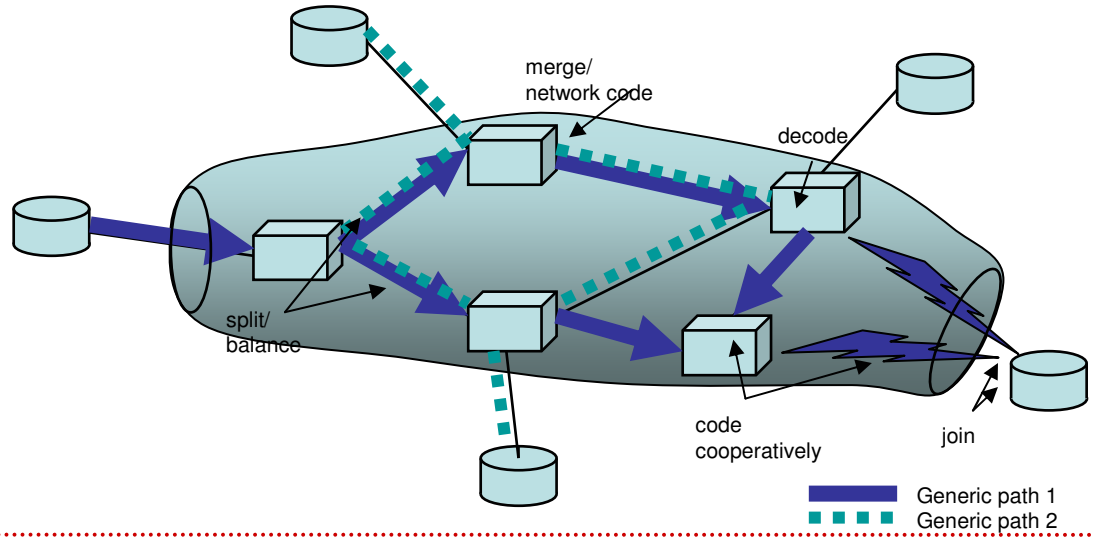
# Technologies for a Content Network: Name-based Routing

- Name-based (Request) Routing
  - *Combines* name resolution and routing into a single process
  - A request like Get(X) does not include the location of an object!
  - Can achieve lower *latency* than DHT
  - Enables proactive transparent *caching* in the network

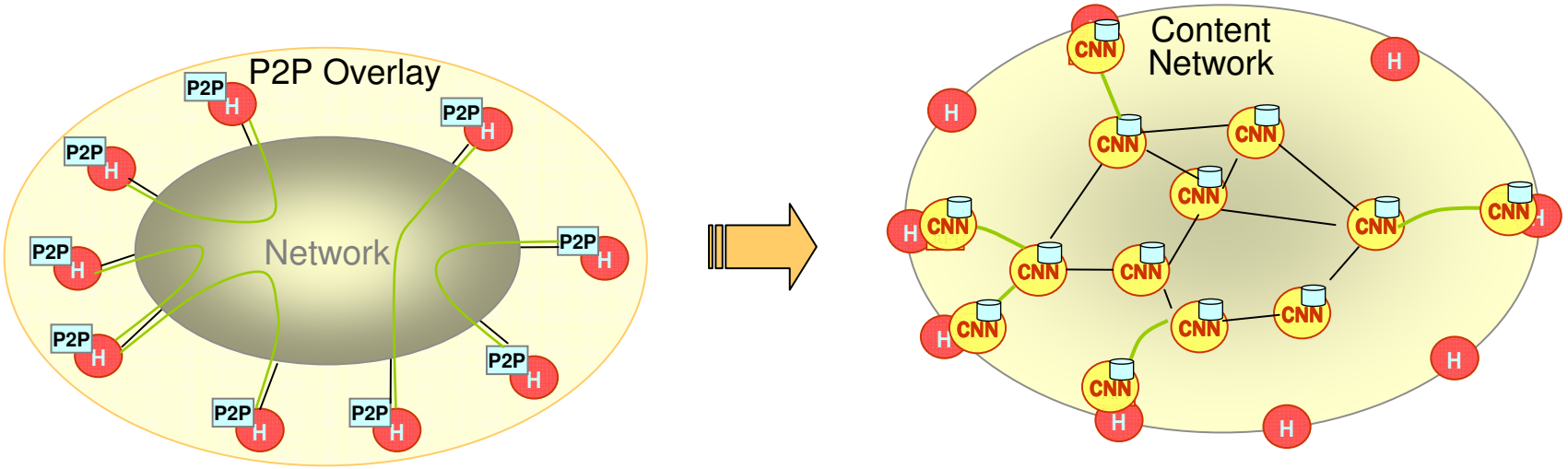


# Technologies for a Content Network: Generic Path

- Path generalisations in a functional architecture
- Incorporate cooperation and coding mechanisms
- Joint source and channel coding possible
- Realising a generic path by routing
- Interactions of multiple generic paths
- Mobility provided from generic paths



# From P2P Overlays to Content Networks




- Common infrastructure (incl. API) for all applications
  - P2P, WWW, IPTV, VoIP, etc.
- Includes network support (e.g., for *caching* and *transcoding*)
- Network awareness of application needs (e.g. QoS)
- Awareness of network characteristics (e.g. topology)
- Better resource usage and accountability

# Future Content Network - Conclusions

- We have a media Internet today where traditional hierarchical delivery structures do not work anymore
- New dynamic business roles become possible: Producers, enhancers and consumers as interchangeable roles
- Reliable content look-up and access is needed - a semantic Net where content is the object being addressed (autonomous content)
- A content-centric network simplifies content handling and enables new business
- Research needed to find a minimal set of content independent functions in the Net
- Focus on new opportunities enabled by a Future Content Network

# Task Force Future Media and 3D Internet: **long-term vision**

- *Content* may consist of a combination of distributed media content objects (e.g., video and audio including 3D objects, text, and sensor data), which can be stored, streamed, or be a part of a real-time communication. Different media objects may have been produced by different sources. Major object classes may require different treatment by the network.
- The *future network* natively supports the search, storage, different types of distribution (e.g., push and pull), manipulation (e.g., enrichment and adaptation), protection, and authentication of distributed media content objects.
- *Services* scale up to high number of users and data sources, and provide the resilience needed to support mission-critical and real-time applications. Services can consist of compositions of atomic services that may be controlled in a distributed fashion.
- *Users* will play new roles. They will generate, consume, and mediate content. Users will also be able to create and provide services.

# Task Force Future Media and 3D Internet: **RTD challenges**

- New **access technologies** will be needed to cope with future increases in traffic volumes and more symmetric bandwidth usage patterns.
- New mechanisms for **native searching** (i.e., analyze objects as opposed to only their metadata), including real-time mechanisms, will be needed.
- New mechanisms to **optimize content distribution** from the users' (e.g,. faster transfers), network providers' (e.g., local transfers), and content providers' points of view as well as from an energy efficiency point of view (i.e., to support mobile devices and to be more environmentally friendly) will be needed.
- New mechanisms for **distributed content manipulation** including adaptations (endpoint or network based), combinations, enrichment, and synchronizations will be needed.
- New mechanisms for content identity management, content protection (content integrity and user privacy), and to ensure content veracity (integrity and using reputation systems) and the **right of use** will be needed.
- New mechanisms to evaluate and provide the appropriate **QoE** will be needed.