CONTENT Network of Excellence

CONTENT NETWORKS AND SERVICES FOR HOME USERS

www.ist-content.eu

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Madrid 30th October 2007

Outline

◆ **CONTENT NoE Introduction**

◆ **CONTENT NoE Objectives**

◆ **CONTENT NoE Research Challenges and Roadmap**

◆ **CONTENT NoE Architectural Framework**

CONTENT NoE

- ◆ **NoE IST-2006-38423 www.ist-content.eu**
- ◆ **Networked Audiovisual Systems**
- ◆ **Start date: 1/07/2006**
- ◆ **End date: 30/06/2009**
- ◆ **Project duration: 36 months**
- ◆ **Total budget: 2,648,000 €**
- ◆ **11 partners from 10 countries:**
  - ❖ **University Carlos III de Madrid (UC3M) (coordinator)- Spain**
  - ❖ **Universitat Politècnica de Catalunya - CCABA (CCABA-UPC) -Spain**
  - ❖ **Lancaster University (ULANC) – United Kingdom**
  - ❖ **University Pierre and Marie Curie (Paris 6) (UPMC) - France**
  - ❖ **University of Coimbra (UC) - Portugal**
  - ❖ **National and Kapodistrian University of Athens (NKUA) - Greece**
  - ❖ **Technische Universität Darmstadt (TUD) - Germany**
  - ❖ **AGH University of Science and Technology (AGH) - Poland**
  - ❖ **Universitet i Oslo (UiO) - Norway**
  - ❖ **Delft University of Technology (TU Delft) – Netherlands**
  - ❖ **Consorzio Interuniversitario Nazionale per l'Informatica CINI - Laboratorio Nazionale per l'Informatica e la Telematica Multimediali ITEM at University of Napoli (CINI/UoN) - Italy**

Industry Advisory Board (IAB)

- ◆ **Philips Research, Eindhoven, NL**

- ◆ **Agilent Laboratories, UK**

- ◆ **Danet GmgH, DE**

- ◆ **Thales Broadcast & Multimedia, FR**

- ◆ **Ericcson Research, IR**

- ◆ **Telefónica, Publicidad e Informacion, ES**

- ◆ **TECHMATH – Blue – Order, UK**

- ◆ **Alcatel-Lucent, BE**

- ◆ **Nokia Research, FI**

- ◆ **Telefonica Research Lab Barcelona, ES**

- ◆ **Google Switzerland GmbH, CH**

- ◆ **TANDBERG ASA, NO**

CONTENT Objectives (I)

◆ **We seek to integrate our research expertise on the different levels of *(overlay) networks* and *services* for *AV content* and put special emphasis on the new challenges that arise from *community networks* and *future end-user services for AV content.***

CONTENT Objectives (II)

◆ **Integrate existing research and training capacities, in order to**

◆ **increase the quality and relevance of our joint research and education, in order to**

◆ **achieve global impact in science, performing technology transfer to industry and standardization bodies**

CONTENT Objectives (III)

Content Service Networks: Three system planes addressed concurrently in joint research activities:

- ❖ **Community Networks: community networks connectivity; service guarantees**
- ❖ **Overlay Networks: end-to-end view fo AV services; autonomic content distribution; modelling, measuring and evaluation**
- ❖ **Content Service networks: Content network architecture and services framework; service interaction; service instances**

CONTENT Objectives (IV)

◆ **In pursuing its objectives, CONTENT carries out:**

  ❖ **Management activities**

  ❖ **Joint research activities structured in three technical areas**

  ❖ **Integration and training activities**

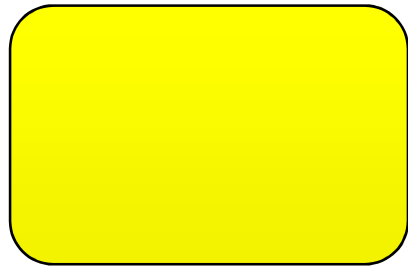 ❖ **Spreading of excellence and dissemination activities**

Research Challenges and Roadmap

- **Background**

- **Architecture**

- **Research Challenges**
  - ❖ **Community Networks**
  - ❖ **Overlay Networks**
  - ❖ **Content Service Networks**
  - ❖ **Cross layer issues**

- **Roadmap**
  - ❖ **From CDNs to CNs**
  - ❖ **Flexibility**
  - ❖ **Metadata**

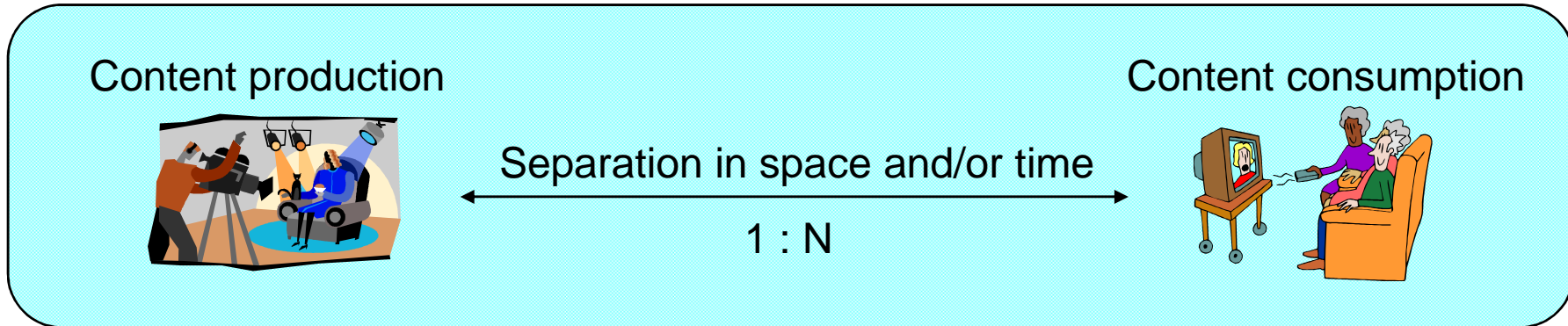# Why CDNs?

◆ **Technical development:**

➔ **Digital representation is dominant**

◆ **Affordable devices allow direct production**

❖ **MPEG or DV based**

❖ **For broadcasting, movie theatres, domestic use, etc.**

❖ **Not just by professionals.**

➔ **There is an explosion of digital multimedia content**

Why CDNs? (cont.)

Content production — Separation in space and/or time — 1 : N — Content consumption
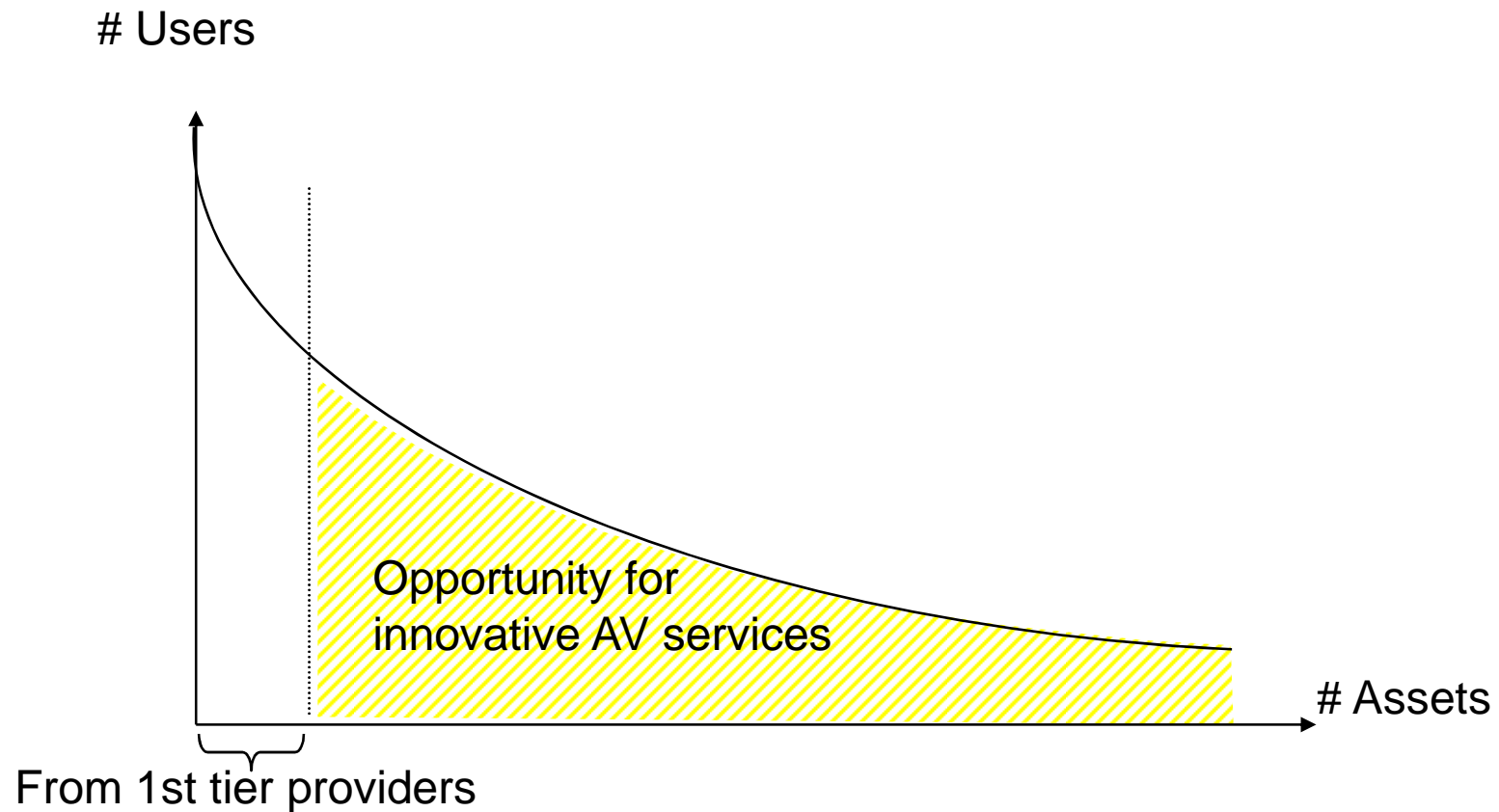
- ◆ **Content Distribution Network (CDN) is an infrastructure designed to efficiently deliver content to the users**
    - ❖ **E.g. broadcast networks for television**
- ◆ **Role of IP networks as a basic communication platform for content distribution is becoming more important**
    - ❖ **More digital multimedia content**
    - ❖ **Better access technology (xDSL, cable, etc)**

Generations of CDNs

◆ **1st generation CDNs (today)**

❖ **Mostly content presentation**

✓ **Simple video streaming**

❖ **Fairly static structure, manual content placement, etc**

◆ **Better computing, networking, compression and synchronization technologies allow new applications**

◆ **Users can then select media elements and control application**

➔ **Need for 2nd generation of CDNs**

Content Networks for Communities

Users

Opportunity for innovative AV services

Assets

From 1st tier providers

Content Networks for Communities

Past   Present   Future
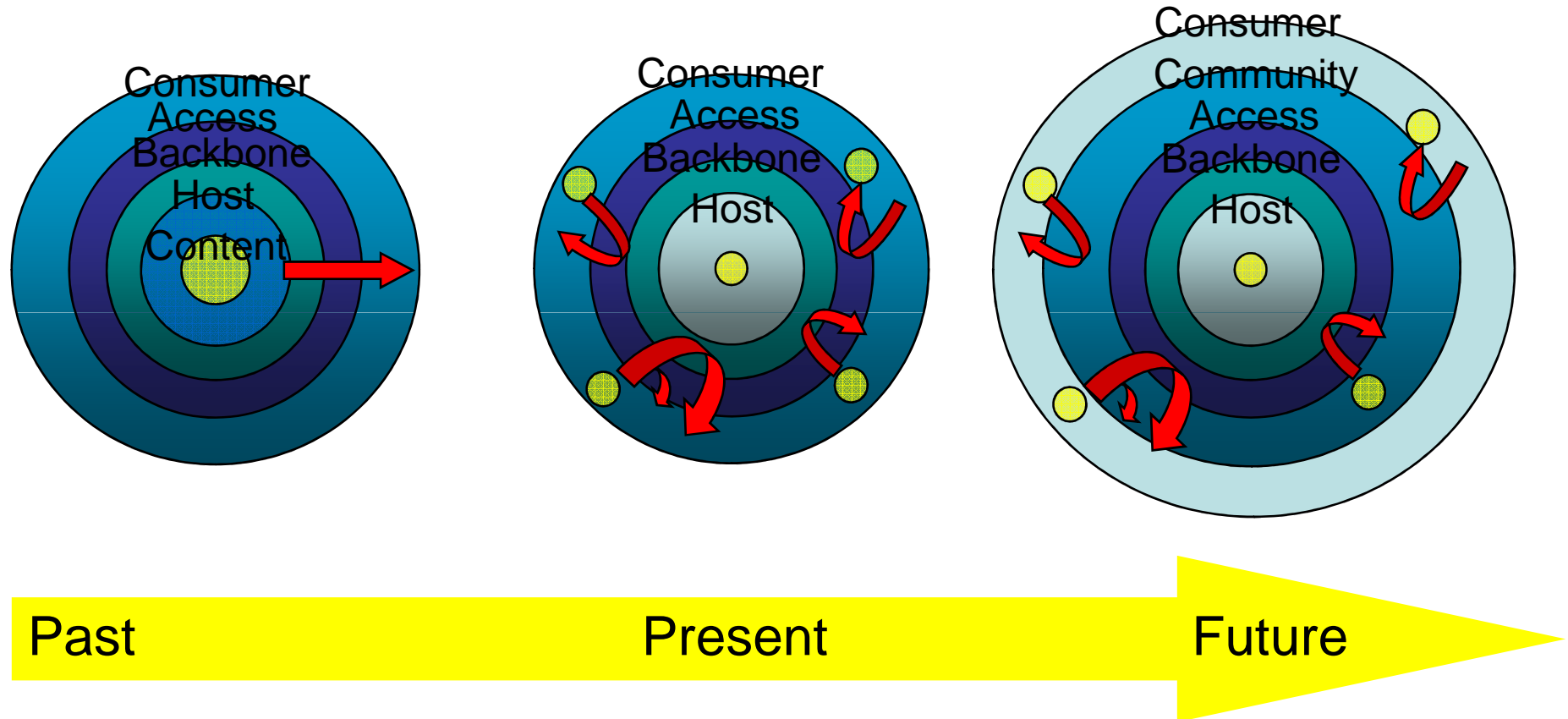
Our Home Turfs

◆ *Community Networks*: covering the home networking infrastructure and the access network.

  ❖ connectivity

  ❖ service guarantees

◆ *Overlay Networks*: providing and end-to-end view for AV services.

  ❖ e2e issues

  ❖ autonomic content distribution

  ❖ modelling

  ❖ measuring

◆ *Content Service Networks:* providing a set of services and the composition of simple services to more complex ones.

  ❖ services framework

  ❖ service interaction

  ❖ service instances

CONTENT Research Planes

Functional aspects

combination

discovery

Service Networks

Caching

Routing

Overlay Networks

Mobility mgmt

Routing

Community Networks

resilience   performance

Non-functional requirements
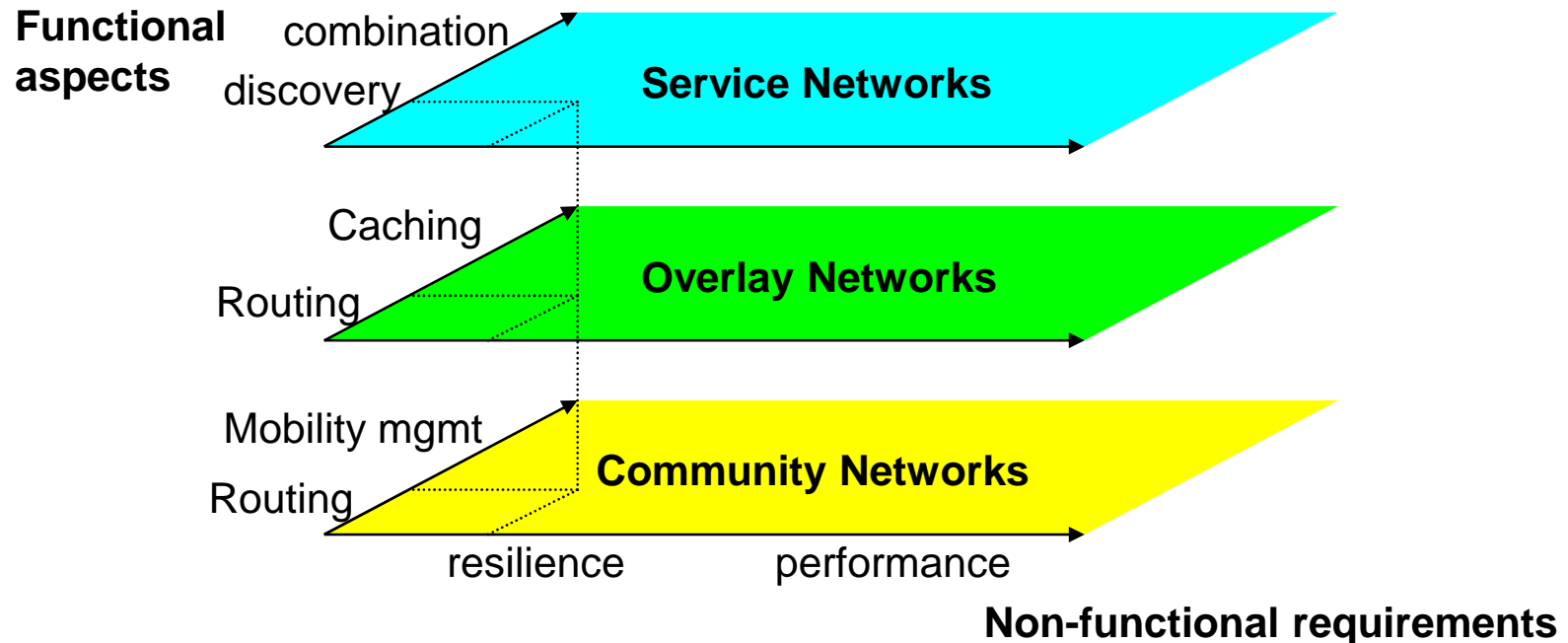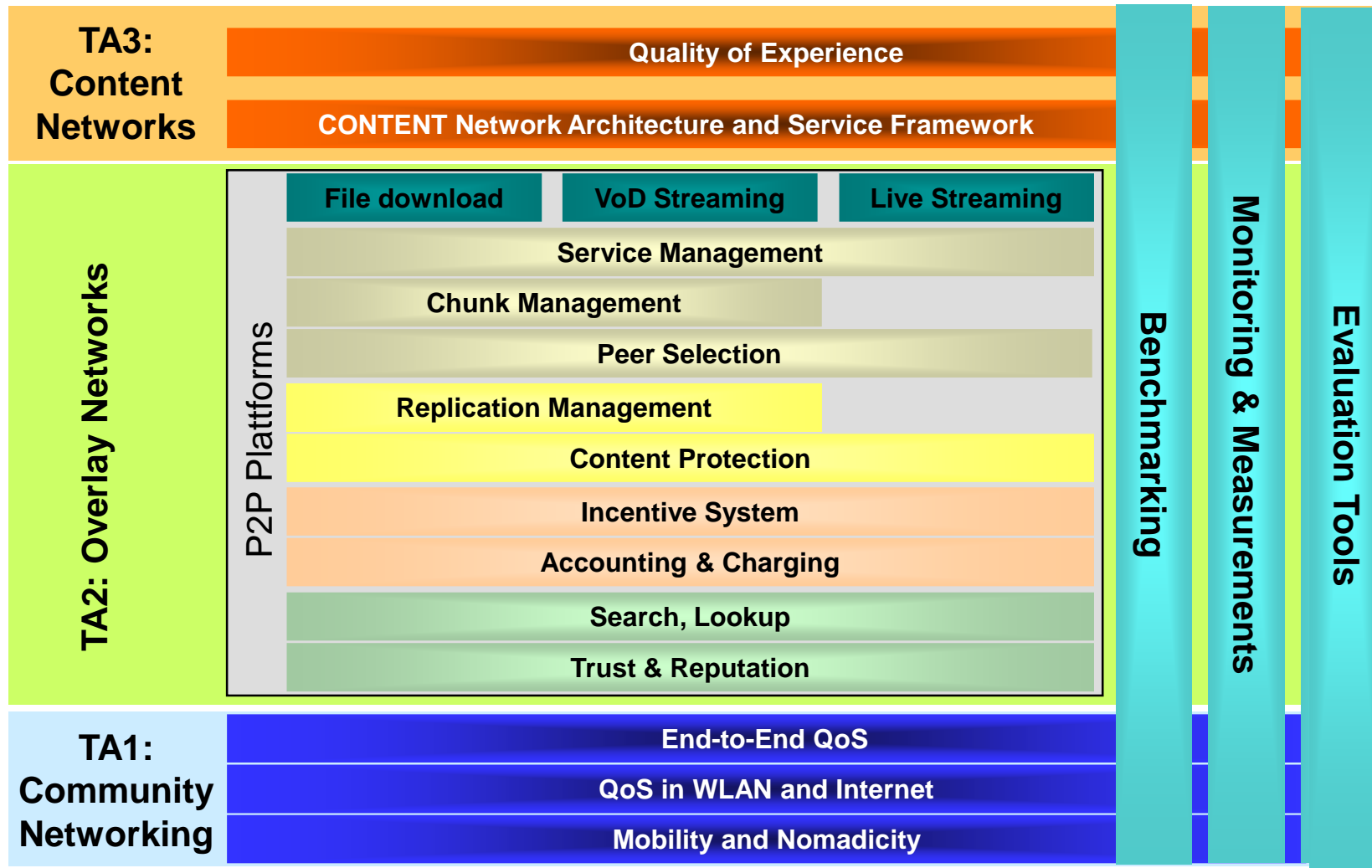
■ The concept of planes and layers is used to split up the complex system into more "manageable" parts

■ However, we are aware that there are many interdependencies between the planes and also many cross layer issues

Research Framework

Research Challenges: Community Networks

◆ **Mobility in heterogeneous environments**

- ❖ **Multi-homed mobile nodes & mobile IP**
- ❖ **IEEE 802.21, mobility, and adaptation**

◆ **IEEE 802.11/802.16 & QoS**

- ❖ **Improve MAC layer**
- ❖ **Traffic control, signalling, mobility mechanisms**
- ❖ **Simulation**

◆ **Misbehaviour detection in IEEE 802.11**

◆ **Wireless mesh networks**

- ❖ **Channel assignments and routing (link selection)**

Research Challenges: Overlay Networks

◆ **Overlays without relying on centralized computing facilities**

◆ **P2P networks in any flavour**

  ❖ **Download**

  ❖ **Live-streaming**

  ❖ **Media-on-Demand**

◆ **Resilience, self-configuration, and autonomicity**

◆ **Dynamicity of peers**

◆ **Trust and incentives**

Research Challenges: Content Service Networks

◆ **Based on basic network and overlay solutions for delivery**

◆ **Architecture and service framework issues**

 ❖ **Service interactions**

 ❖ **Integration of service instances**

◆ **Devise a general model that can accommodate different service types and interaction models**

◆ **To make it more concrete:**

 ❖ **Co-ordination and management of autonomous services in a unifying architecture**

 ❖ **Semantic service discovery for complex autonomous services**

 ❖ **Service representation and integration within a unifying content network architecture**

Research Challenges: Cross Layer Issues

◆ **Avoid redundant functionalities**

  ❖ **E.g. monitoring in community and overlay networks**

◆ **Enable overlays and content services to be**

  ❖ **Context aware**

  ❖ **Resource aware**

  ❖ **Location aware**

◆ **Coordinate adaptations**

◆ **Specify and measure QoS parameters and other metrics to**

  ❖ **Assess underlying communication technologies**

  ❖ **Organize efficient and resilient overlays**

  ❖ **Suggest most suitable service instances**

Research Challenges:
Cross Layer Issues (cont.)

- ◆ **Service discovery at every plane**

- ◆ **Autonomic solutions needed at every plane**
  - ❖ **Configuration, management of community networks**
  - ❖ **Adaptation and optimization of overlay networks**
  - ❖ **Management of content networks**

- ◆ **Measurements and benchmarks**
  - ❖ **Realistic workloads**
  - ❖ **Realistic configurations**
  - ❖ **Scientific approach: repeat and compare**

Road Map

2020

2015

2010

2008

Fully Interactive CN

Misbehaviour Sensitive Networks

End2End Infrastructure

Integrated Multihome Networks

Optimised delivery

Autonomous Content Distribution

Network Caching

DSMS

Proactive Content Placement

Dynamic Content Services

Context Aware Content Delivery

Auto. Content Services

Content Adaptation

SOA based CN

Exploiting Content Characteristics

Types & Number of CDN

Research CDN

Heterogeneity

Scalability

Adaptability

CDNs – The "Historic" Perspective

Today

1st generation: main issues streaming and presentation
→ static content, static management

Stored content

Live content

- More interactivity with the content
- Combining and customizing of content
- Users push content into the CDN
- Editing of content
- Harder management tasks

Future

Dynamic content

Requirements on next generation(s):
- efficient read access, navigation, search and retrieval
- efficient support for distr. customization, composition and editing
- efficient management

The Need for Flexibility

◆ **CDNs of the future:**

  ❖ **No more static specialized infrastructures, but …**

  ❖ **Flexible, dynamic, multi-service content-centered infrastructures, supporting:**

  ✓ **The concept of dynamic user communities**

  ✓ **The entire life cycle of each piece of content, and of combinations of them**

  ✓ **Mobility of users**

  ✓ **A variety of networking technologies**

  ❖ **Emerging paradigms well fitting these needs:**

  ✓ **P2P and Overlays**

  ✓ **Self-describing, composable services**

  ✓ **Self-describing, composable pieces of content (metadata)**

The Need for Metadata

◆ **Modern content must consist of two parts**

   ❖ **The encoded media**

   ❖ **The metadata**

      ✓ **Data about the data (data about the media)**

      ✓ **Description of the content**

      ✓ **Format and location related metadata**

◆ **Metadata is needed for**

   ❖ **Efficient content search and retrieval**
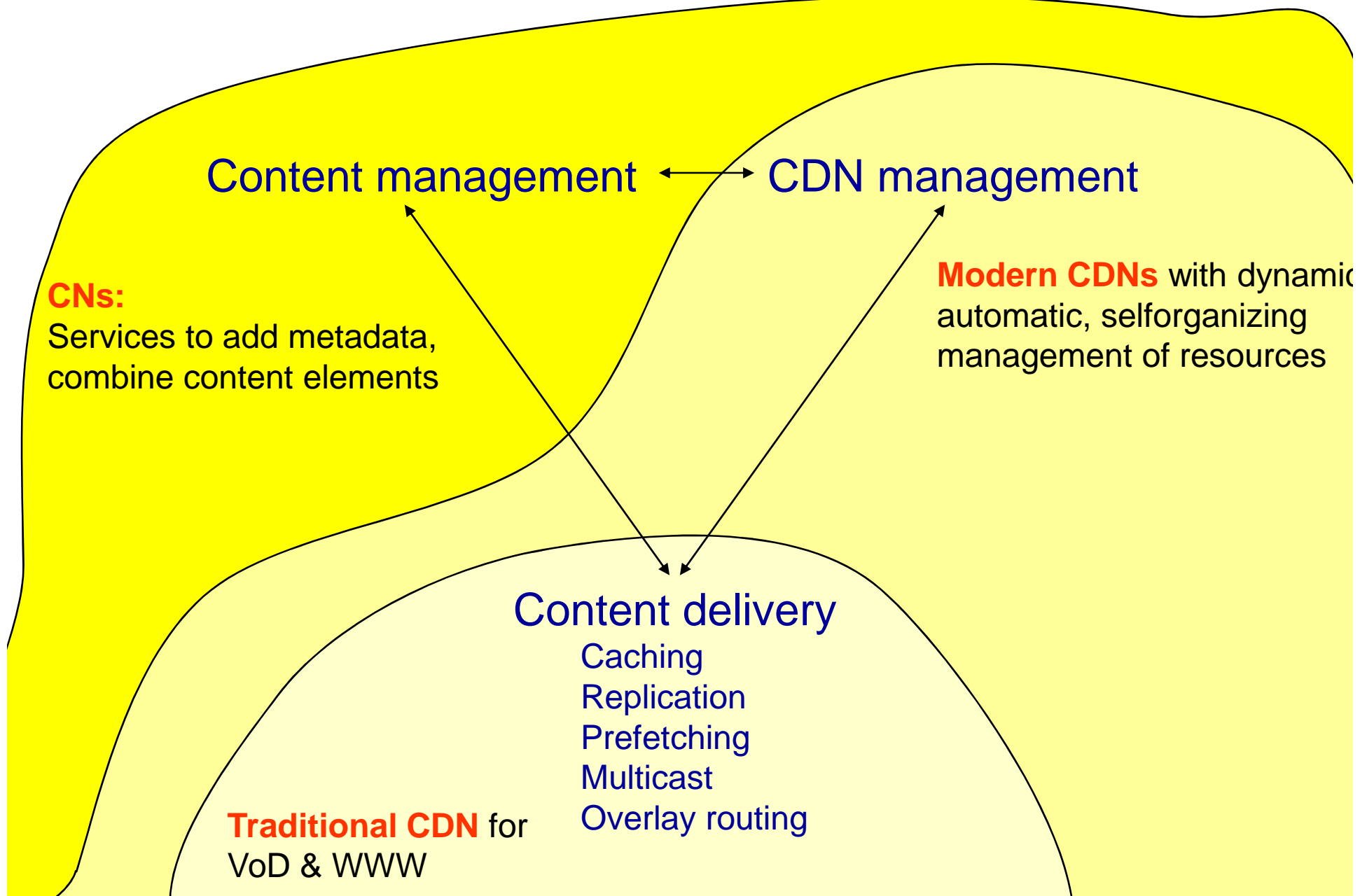
   ❖ **Content placement in the CDN**

◆ **Metadata can be created manually**

   ❖ **But a challenge is to extract from media and produce automatically**

The Need for Metadata (cont.)

◆ **Metadata will allow advanced CDN operations:**

  ❖ **Complex content composition**

  ❖ **Search**

  ❖ **Efficient retrieval**

  ❖ **Exploitation of inherent structural and/or semantic characteristics**

  ❖ **Placement based on access/usage pattern**

  ❖ **Effective delivery mode**

  ❖ **Content adaptation**

◆ **In CDN, content items are prime objects of distribution and management**

  ❖ **Entire operation of the CDN centres around content, its distribution and all processes related to it**

From CDNs to Content Network

Content management ↔ CDN management

CNs:
Services to add metadata,
combine content elements

Modern CDNs with dynamic
automatic, selforganizing
management of resources

Content delivery
Caching
Replication
Prefetching
Multicast
Overlay routing

Traditional CDN for
VoD & WWW

Synergies with Industries and Users

◆ **CONTENT has established a strong relation with Industry, to both receive useful inputs and provide useful outputs to companies that are playing a significant role in the AV market**

  ❖ **Companies like Philips, Microsoft, Agilent, Thales, Telefonica, Ericsson Ireland, TDF, Danet, Blue Order have close contacts with the project through its IAB**

◆ **CONTENT has also established *User Groups* representing the different stake holders in the content life cycle**

  ❖ **In UK (Lancaster), Poland (AGH), France (LIP6), Germany (Darmstadt) and Italy (CINI)**

  ❖ **Users are preferentially non-technical persons**

Relation with standards

◆ **CONTENT partners are contributing to many standardization groups**

◆ **IETF Groups:**

  ❖ **AVT: Audio Visual Transport**

  ❖ **SIPPING: Session Initiation Proposal Investigation**

  ❖ **XCON: Centralized Conferencing**

  ❖ **NSIS: Next Steps in Signaling**

  ❖ **NEMO: Network Mobility**

  ❖ **Site Multihoming for IPv6: SHIM6**

◆ **ISO/IEC MPEG: QoS framework, Group Communications**

◆ **IFIP WG6.3: Performance of Communication Systems**

◆ **SMPTE: Metadata Dictionaries**

◆ **…**

Stimulating tighter collaboration and integration

◆ **Special emphasis to "*make PhD students eager*" to collaborate:**

  ❖ **PhD workshops in parallel to management oriented plenary sessions**

  ❖ **Incentive: address joint problems**

    ✓ **Testing of research work**

    ✓ **Evaluation of research work**

    ✓ **Measuring system characteristics**

    ✓ **Sharing tools and data sets**

    ⇨ **See highlights of joint work ("Benchmarking" Activity, P2P simulation, etc.)**
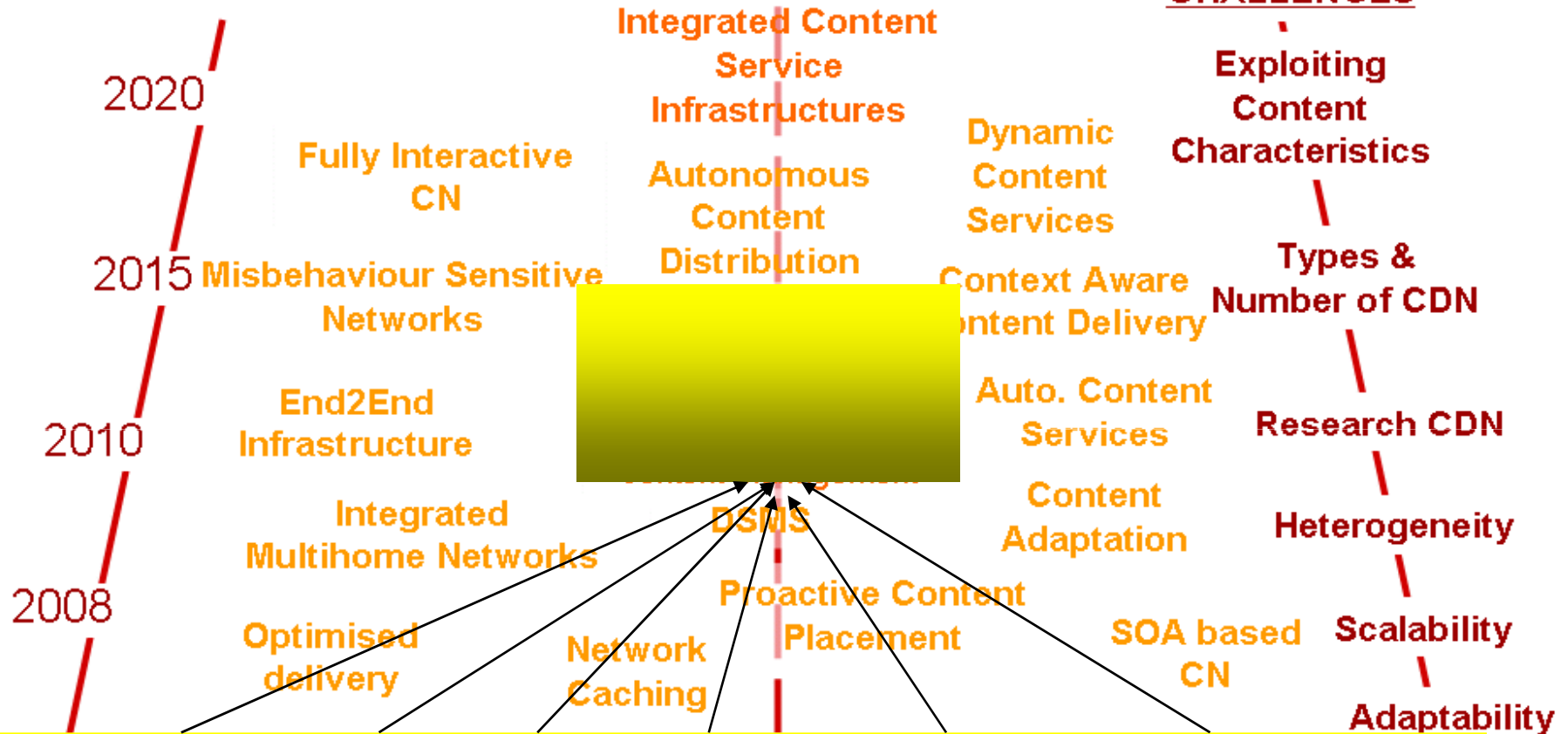
Highlights of joint research:
"Benchmarking" Activity

Road Map

CHALLENGES

2020

Integrated Content Service Infrastructures

Exploiting Content Characteristics

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Dynamic Content Services

Autonomous Content Distribution

2015 **Misbehaviour Sensitive Networks**

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Scalability

Adaptability

CONTENT
Content Distribution Network Research

Information Society
Technologies

Main Conclusions

- ◆ **Integrated research is picking up speed and has produced already many important results in the first year**

- ◆ **PhD collaboration is working!**

- ◆ **Prospects of important impacts, especially through cross layer work and benchmarking**

- ◆ **Some more general conclusions:**

  - ❖ **Many research issues, but …**
    … cross layer issues are the most challenging

  - ❖ **Examples:**

    - ✓ **Autonomic solutions**

    - ✓ **Monitoring**

    - ✓ **Benchmarking**

  - ❖ **The only way to go:**

    - ✓ **"Inter-disciplinary" teams/configurations, i.e. NoEs, well working clusters, ++**

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