

TOWARDS A FUTURE INTERNET PUBLIC PRIVATE PARTNERSHIP

SECOND USAGE AREA WORKSHOP, 21-22 JUNE 2010, BRUSSELS, BELGIUM

CONTENT usage area

Position Paper on issues and open questions to be addressed during the workshop on the usage area of content, input from the research center IBBT.

(Q1) What use case and scenario in your area would you consider the most appropriate and representative one for large-scale experimentation with the Future Internet platform to be built starting from 2013?

The surge of Future Internet services and systems for multimedia consumption requires innovative content management solutions for content production, archiving, indexing, browsing, searching and delivery, in a massively distributed way. Content will be available in different forms (from user-generated to premium 3D content), over different networks (from public Internet and P2P networks to private CDNs and production companies), to heterogeneous devices (from mobile devices to 3D TVs) in multiple environments (from home environments to collaborative work places), each with different QoS requirements (from best effort to very high quality).

Therefore, large-scale experimentation in this usage area would involve three main scenarios:

- For efficient **content delivery** to the end-users, next-generation networking infrastructures will have to cope with stringent requirements in terms of bandwidth, delay, jitter and connectivity. In order to allow for an efficient interconnection of delivery platforms, open and standardized solutions are essential.
- In order to allow **content indexing and search**, automated metadata extraction and content annotation during the archiving process become more and more important, as well as distributed indexing mechanisms for browsing and searching world-wide content.
- Collaborative multimedia **content production** and distribution environments are faced with the challenges of storing and processing massive amounts of digital multimedia data online.

(Q2) What innovative Internet functionality and technologies would you consider important for your suggested use case and scenario (e.g. context awareness, sensor networks, advanced real time processing capabilities handling huge volume of data, ad hoc service composition and mash-up, managed broadband connectivity and services, embedded media support for interfaces easing the interpretation of processed contextual data, etc.)?

In the area of multimedia **content delivery**, there is a clear need for more intelligent and autonomous management solutions to cope with the increasing number of networked resources, services and content, as well as the rising variability in traffic and connectivity patterns. In order to properly evaluate autonomous and cognitive decision engines, huge

amounts of contextual monitoring and sensor data should be collected, filtered and translated from distributed and heterogeneous networked sources.

Additionally, autonomous machine learning techniques for cooperative caching will bring content closer to end users, thus significantly improving the quality of experience.

Solutions for scalable **content indexing and search** require descriptive metadata formats for automated annotation based on textual and audiovisual information extraction. Intelligent and personalized browsing, searching and recommendation can only be supported through links with dynamically updated semantic knowledge stores. Data and opinion mining from textual content on websites and social networking platforms will become increasingly important. Distributed solutions for indexing content and storing metadata and knowledge, based on distributed hash tables, are necessary to provide scalability and robustness.

Collaborative production and broadcast companies require novel technologies to support (distributed) multimedia **content (post-)production**, ingesting, archiving and playout in an open and cost-effective way. Reliable, highly performing and secure media grid architectures for management and retrieval of this data have to be tailored to specific company profiles, application characteristics and service requirements, in order to efficiently manage workflows in a timely and quality-aware manner.

(Q3) Which of the identified functionalities would you expect the Future Internet core technology platform to deliver to support your and other usage area scenarios?

The core platform should provide common functionalities to support the integration of a variety of usage scenarios, such as resource and service discovery, addressing and monitoring, with built-in security.

Additional important functionalities specifically for multimedia consumption include the following:

- scalable data collection from heterogeneous resources
- real-time data processing capabilities
- content-centric networking mechanisms including content addressing, service discovery and composition and transparent content caching and (re-)placement
- reliable and ubiquitous network connectivity

(Q4) What kind of experimentation environment would you consider necessary for broad large scale testing of the platform to be developed in your use area? What would be needed to experiment new services and applications cutting across use areas (services and application mash-up) and building a new services and application ecosystem around the prototype implementations of the platform?

A wide variety of experimental validation options, ranging from in-lab proof-of-concept setups to large-scale emulated and real-life trials, should pave the way for the actual operational deployment of the proposed content distribution system. Cross-domain and cross-layer experimentation infrastructures are primordial to allow for scalable and realistic testing. While cross-domain aspects focus on the interconnection of public, experimental and emulated networks, for delivering content over core and access into home networks, cross-layer experimentation deals with the integration of monitoring components for hardware (content servers and caches), content delivery networks and video streaming service instances.

Experimental validation of next-generation **content delivery** platforms requires large-scale Internet field trials involving the whole value chain, from fixed and mobile network operators to content delivery service providers. Since the personalized user experience is very important for **content browsing, search and recommendation** solutions, the participation of a wide variety of geographically dispersed end users with different devices and diverse social and

cultural backgrounds, is primordial. **Content production** environments benefit from in-lab experiments to showcase the highly performing media grid infrastructures, while the interconnection with other players in the ecosystem can be demonstrated by field trials.

(Q5) How do you see the potential role of your organisation in the FI-PPP, in the context of Usage areas taking a prominent role in the Initiative, to ensure an appropriate application driven approach.

IBBT (Interdisciplinary Institute for Broadband Technology) is engaged since it's beginning in 2005 in user-centred inter-disciplinary research. The research projects initiate explicitly from the user needs and the analysis of the user's expectations. Effort is being made at the kick off of the projects, in order to make all non-technical issues explicit in the research track, such as: usability, legal issues, value network analysis, techno-economical issues, potential factors inhibiting future valorisation. Close collaboration in-between technical research groups, non-technical research groups, industry and user communities are built-in into the IBBT GBO and ICON project structure. IBBT has built-up valuable knowledge in the area of inter-disciplinary research methodologies.

IBBT has a proven track record on technological research in the Future Internet area. Two national test labs have been created during the past years, namely iLab.t and iLab.o, both complementing each other and valuable assets to the FI-PPP initiative. The interconnection of the IBBT iLab.t test beds for fixed (*Virtual Wall*), wireless and sensor (*WiLab*) networks will allow for large-scale emulated experimentations for a wide variety of content delivery services and applications. In this way, the core platform components can be validated early on in the design process to provide relevant feedback.

Important core platform components IBBT will contribute to and provide support for include intelligent generic modules for content demand pattern prediction, resource monitoring and enforcement through cognitive engines for content placement and network management. A more detailed description of IBBT research topics and projects on multimedia consumption can be found in the IBBT competence paper on the FI-PPP usage area "Content Management" in annex.

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APPENDIX: CONTENT MANAGEMENT AT IBBT

The surge of Future Internet services and systems for multimedia consumption requires innovative content management solutions for content production, archiving, indexing, browsing, searching and delivery, in a massively distributed way. Content will be available in different forms (from user-generated to premium 3D content), over different networks (from public Internet and P2P networks to private CDNs and production companies), to heterogeneous devices (from mobile devices to 3D TVs) in multiple environments (from home environments to collaborative work places), each with different QoS requirements (from best effort to very high quality).

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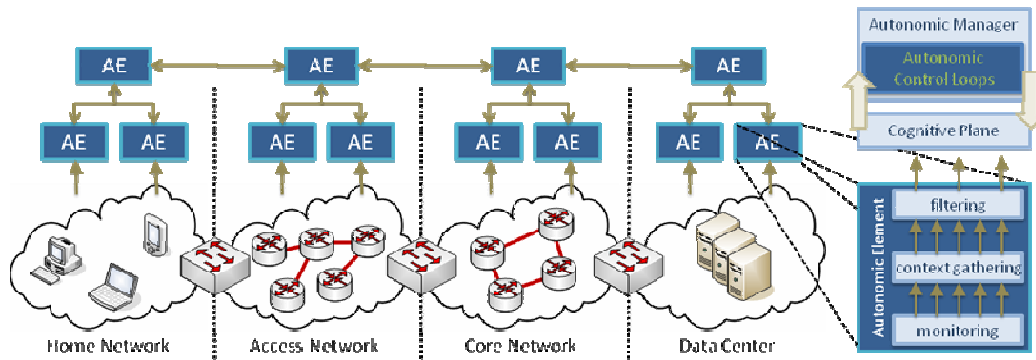
In the following sections, the competences of IBBT on these content management topics are detailed.

Large-scale multimedia content delivery

IBBT has a strong interest in research areas related to multimedia content delivery. Besides architectural studies and network capacity planning, the focus is mainly on content formatting, networking algorithms and protocols, as well as their interactions.

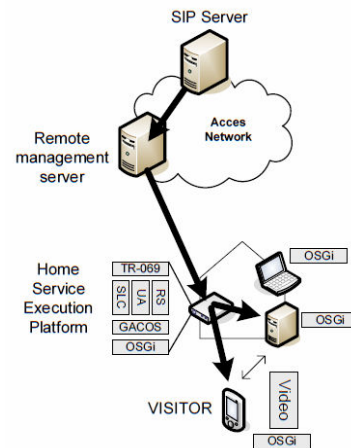
Different content formats allow for more personalized and adaptive service delivery to heterogeneous end user devices. The video quality can be adjusted at the server side or dynamically in the network using on-the-fly transcoding or layer dropping techniques.

Content Distribution Networks further benefit from networking algorithms and protocols that provide congestion and admission control and distributed content storage that enhance the QoS for scalable video delivery. To meet the increasing quality requirements for such services, intelligent components are deployed closer to the end users, up to the edge of the access networks (at the access multiplexers) or even home networks (at the home gateways). Peer-to-peer mechanisms complement the abovementioned techniques, adding scalability, robustness and self-organization features to the delivery system.



Intelligent autonomous network management functionality can be used to further automate management decisions through AI techniques based on input from monitoring components.

To realize QoS-enabled content delivery into the home networks, the convergence of currently co-existing technologies is taking place. Standardized architectural solutions for in-home QoS reservation, interworking of heterogeneous devices and storage facilities and remote access are studied.



Large-scale evaluation of the designed systems is performed using simulation environments, realistic emulation platforms such as the Virtual Wall and lab setups for subjective video quality testing. IBBT's Virtual Wall environment consists of 100 high-end servers, interconnected by a lossless terabit switch, and allows for an automated and close to real life system configuration and deployment with advanced monitoring and visualization capabilities.

Reference Projects and role of IBBT-IBCN

- FP6-IST MUSE: Multi-Service Access Everywhere
 - o Network dimensioning and segment-based caching for time-shift television
- CELTIC RUBENS: Rethinking the Use of Broadband access for Experience-optimized Networks and Services
 - o Admission and congestion control for video-on-demand (VoD)
- FP7-IST OCEAN: Open Content Aware Networks
 - o Caching (using machine learning techniques) and network management
- IWT CoDiNet: Content Distribution Networks
 - o Network dimensioning, server and content placement for VoD in CDNs
- IWT Q-MATCH: Quality-Monitoring, Adaptation, Transport and Control of multimedia services into the Home
 - o Management of streaming sessions and subjective video quality measurement for VoD
- IBBT VIDEO Q-SAC: Video To The Home – Quality Sensing, Aggregation & Control
 - o Subjective video quality measurement for VoD
- IBBT OMUS: Optimizing MULTimedia Service Delivery to home networks
 - o QoS for video streaming in home networks and P2P video delivery

Reference Publications

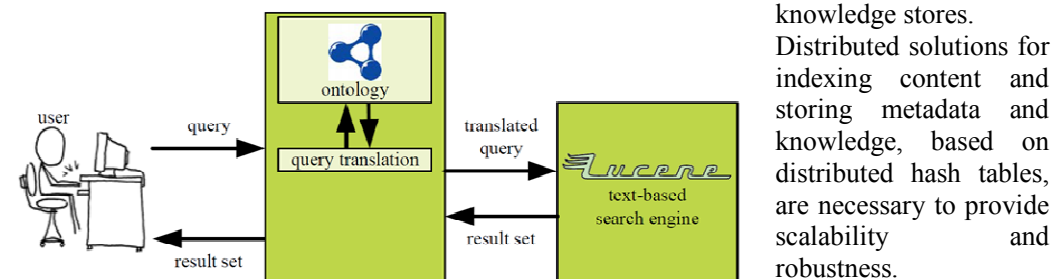
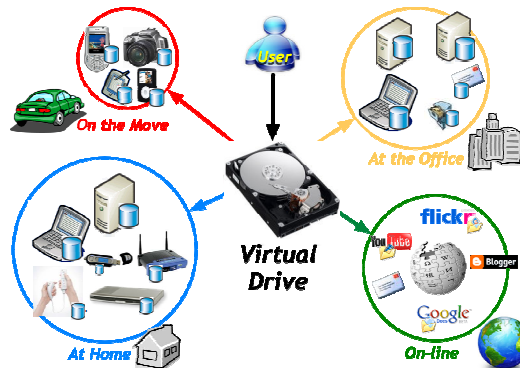
- T. Wauters, W. Van de Meerssche, P. Backx, F. De Turck, B. Dhoedt, P. Demeester, T. Van Caenegem, E. Six, "Communication networks proxy caching algorithms and

- implementation for time-shifted TV services", published in European Transactions on Telecommunications, March 2008, Vol. 19, Issue 2, pp. 111-122.
- S. Latre, P. Simoens, B. De Vleeschauwer, W. Van de Meerssche, F. De Turck, B. Dhoedt, P. Demeester, S. Van den Berghe, E. Gilon-de Lumley, "An autonomic architecture for optimizing QoE in multimedia access networks ", Computer Networks, 14 July 2009, pp. 1587-1602.
 - J. Famaey, T. Wauters, F. De Turck, B. Dhoedt, P. Demeester, "Network-aware Service Placement and Selection Algorithms on Large-scale Overlay Networks", published in Computer Communications, 04 March 2010.
 - A. Manzalini, P. Deussen, S. Nechifor, M. Mamei, R. Minerva, C. Moiso, A. Salden, T. Wauters, F. Zambonelli, "Self-optimized Cognitive Network of Networks", published online in The Computer Journal, March 23, 2010.
 - D. Verslype, J. Nelis, T. Verschueren, W. Haerick, F. De Turck, C. Develder, "Framework for ubiquitous discovery and access to home services", published in Proceedings of Computation World2009, ISBN 978-0-7695-3862-4, Athens, Greece, 15-20 November 2009, pp. 398-403.

Content indexing, search and discovery

Searching vast and highly distributed amounts of content, both user-generated and commercial, is only feasible if descriptive metadata is made available through automated metadata extraction and annotation. IBBT studies methods from data mining and computational linguistics to extract relevant keywords from textual content on websites and social networking platforms.

Linking such semantic information with ontology-based knowledge stores provides more intelligent and personalized functionalities for browsing, searching and recommendation. Related research focuses on automated knowledge mining and verification from a variety of online sources to further increase semantic information in existing knowledge stores.



Distributed solutions for indexing content and storing metadata and knowledge, based on distributed hash tables, are necessary to provide scalability and robustness.

Reference Projects and role of IBBT-IBCN

- IBBT PECMAN: Personal Content Management
 - o Distributed hash tables for personal content indexing and search
- IBBT BOM-VL: Disclosure of multimedia archives in Flanders
 - o Computational linguistics for metadata extraction from textual sources
- IBBT VLIB: Audiovisual content in Flanders
 - o Improved content search through ontology-based knowledge stores
- IWT-MEDIADRAIN: Multimedia archiving on a distributed redundant architecture of independent storage nodes
 - o Optimization of search and retrieval of video content

Reference Publications

- S. Vandamme, J. Deleu, T. Wauters, B. Vermeulen, F. De Turck, "CROEQS: Contemporaneous Role Ontology-based Expanded Query Search — Analysis of the result set size", International Workshop on Image Analysis for Multimedia Interactive Services (WIAMIS), London, United Kingdom, 06-08 May 2009.
- S. Vandamme, J. Deleu, T. Wauters, B. Vermeulen, F. De Turck, "CROEQS: Contemporaneous Role Ontology-based Expanded Query Search — Implementation and evaluation", International Conference on Software and Networks Communication (ICCSN), Macau, China, 27-28 February 2009.
- N. Sluijs, T. Wauters, B. De Vleeschauwer, F. De Turck, B. Dhoedt, P. Demeester, "Caching Strategy for Scalable Lookup of Personal Content", The First International Conference on Advances in P2P Systems (AP2PS 2009), Sliema, Malta, 11-16 October 2009.
- F. Iterbeke, S. Melis, B. De Vleeschauwer, T. Wauters, F. De Turck, B. Dhoedt, P. Demeester, B. Theeten, T. Pollet, "An open peer-to-peer based platform for scalable multimedia communication", International Conference on Parallel and Distributed Processing Techniques and Applications (PDPTA), ISBN 1-60132-082-5, Las Vegas, 14-17 July 2008, pp. 398-403.

Collaborative multimedia production

Collaborative multimedia production and distribution environments are faced with the challenges of archiving and processing massive amounts of digital multimedia data online. Management and retrieval of this data has to be carried out in a reliable, highly performing and secure manner. Media grid architectures have to be tailored to specific company profiles, application characteristics and service requirements, in order to efficiently manage workflows in a timely and quality-aware manner. IP based storage infrastructures, with improved protocol performance for file transfer, are put in place to cope with ever-increasing access speeds.



Reference Projects and role of IBBT-IBCN

- IBBT FIPA: File based Integrated Production Architecture
 - o Scheduling algorithms for collaborative workflow execution
- IBBT GEISHA: Grid Enabled Infrastructure for Service Oriented High definition media Applications
 - o Optimization of protocol performance for high-speed file transfer
- IWT-MEDIADRAIN: Multimedia archiving on a distributed redundant architecture of independent storage nodes
 - o Optimization of multimedia content archiving

Reference Publications

- B. Volckaert, T. Wauters, M. De Leenheer, P. Thysebaert, F. De Turck, B. Dhoedt, P. Demeester, "Gridification of collaborative audiovisual organizations through the MediaGrid framework", Journal of Future Generation Computer Systems, May 2008, Vol. 24, Issue 5, pp. 371-389.

About IBBT

The IBBT (Interdisciplinary Institute for Broadband Technology) is an independent research institute for ICT innovation in Flanders, Belgium. It has over 600 researchers dealing with the technological, economic, legal and social dimensions of the development and exploitation of broadband services. The IBBT-IBCN (INTEC Broadband Communication Networks) research group counts around 100 members, specialised in various technology aspects of both fixed and wireless networks, the related services and supporting software and the techno-economic evaluation of the future internet.

List of industry partners

Alcatel-Lucent (network solution vendor)
Aventiv (Nomadesk, data management solution provider)
Comsof (telecom software SME)
Excentis (communication service provider)
IBM (ICT infrastructure provider)
NextiraOne (communication service provider)
Porthus (ICT software solution provider)
Streamovations (video streaming solutions)
Technicolor (Thomson Telecom, home networking solution provider)
Televic (devices/software provider for medical sector, train systems, conferences rooms and e-learning)
Ubizen (software security implementer)
Video Promotion (equipment vendor for broadcasters)
Videohouse (media facility provider)
VRT (national broadcaster)
Woestijnvis (production house)

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