Future Content Networks

Position Paper

1 Vision of the Future Content Network

The Internet is a dynamic entity; constantly evolving. Who would have guessed a decade ago, its current form and capabilities? With the rate of technological development increasing how can we hope to predict the shape of the Future Internet? We attempt to do so based on two certainties; that the technology used to build the Internet will change, and that the fundamental (human) needs that it must ultimately serve, will not change dramatically. Fundamental human needs change on evolutionary timescales, these have been identified by Maslow[1] as the needs for: physiological security (we need food and water); for safety (an expectation that we are not in imminent danger); for love (the need to feel a part of a community); for esteem (the need to feel valued by others) and the need for self actualisation (the desire to achieve that which we are able to achieve).

As communicating, sentient beings the needs for love esteem and self actualisation can be met through communicating and through expression. These lead to the derived needs of:

- Telling, sharing and enjoying *stories*
- *Discovering* new 'stuff' for our community
- *Playing, learning* and *escape*

Whilst our needs change slowly some behaviour does change more rapidly;

- Young people are feeling more comfortable in cyberspace and can move easily between virtual and real worlds

- People are increasingly video literate; able to read and write using the language of film, to communicate stories and emotion

- People trust that content of all forms can be put into and fetched from the Internet and expect this to be done at any place in a secure manner.

- People are finding it easier to share and access content between a range of devices and a range of people.

- People communicate increasingly using a range of media, but also interact with non-human content generators like webcam's and life event monitors.

We should expect the Future Internet to build on these trends, but also to deliver some surprises. We should explore how we can support effective communication, which is as powerful as that experienced when people meet face to face. We need to understand the impact on communication of synthetic gestures, gaze awareness, of increasing graphical realism, of specialised sound as well as exploring tangible multi-modal and multi-sensing interfaces, which may allow people to experience full body interaction and to increase a sense of immersion through interaction with virtual objects. Naturally, the realisation of such "services" demand new network architectures that are generically content aware rather than bit-stream aware, able to handle location and adaptation of content, new types of content, services, users, end-devices and provide reliable quality

---

[1]   H. Maslow, A Theory of Human Motivation, Psychological Review 50 (1943):370-96.

of information, services, experiences, actuation, etc. In other words, the passage to Future Internet heavily depends on the progress of **Future Content Networks.**

2 Future Media

In considering the impact that future media may have on the Future Internet architecture requirements, we foresee four trends that are not mutually exclusive. The impacts these have on architecture requirements are discussed in the next section. These trends are:

- Increasing amounts of user generated content which is better, both artistically and technically, than that available today

- Enhanced content representations 3DTV, Ultra HD TV, holograms, etc.

- New forms of interactive and collaborative storytelling, both professionally created and collaboratively developed by users

- Framed communication experiences including serious, multi-player gaming

More user generated content is the natural consequence of the democratising nature of the Internet, an increasingly video literate user base and the ubiquity of content capture devices. Societally we anticipate, as this behaviour is embraced by the middle majority rather than just the early adopters, a greater discretion might be imposed on the audience with whom content is shared. This will pose greater demands on security and may require new modes of permission and sharing rules to be established. The attraction of user generated content lies in the very human need to create, to share and to show off.

Enhanced content representations such as 3D content, as for example 3DTV, Ultra HD and in the longer future free views and holograms will be standardised, allowing content to be created using new formats. Such content will demand new encoding methods and higher bit rates for successful transmission. Enhanced representation forms will have a significant impact on some technical elements of the production process and on the way signals are encoded and represented. Whether or not this enhanced media has additional impacts on the way stories are conceived, written and distributed is not yet clear. The attraction of such technologies is that they will provide greater degrees of realism and immersion.

New Forms of Interactive Storytelling are expected to emerge from the connected nature of the Internet. The perceived distinction between agency (in games) and narrativity (in storytelling) is being challenged as people develop ways of allowing interaction within a narrative, seeing the interaction as a fundamental part of the storytelling mechanism rather than just a mechanism for exploring or solving problems within a virtual world. Such innovations have a profound effect on the creative industry from script to screen, and in particular on content distribution which is now challenged to deliver unique moving image stories to every viewer. Similar effects have already been witnessed in the game industry where the connected nature of the Internet has allowed a massively multiplayer role playing game to thrive. The attraction of such developments is in the highly personalised and participative nature of the new entertainment forms.

Framed Communication Experiences are new social, media augmented communications experiences that we anticipate becoming popular following developments in standards for screen composition and R&D from games, communication and entertainment industries. These framing experiences are anticipated to be characterised by a mix of live video streams, network based content and user generated content in experiences that may be real time or non real time. Such experiences must effortlessly and attractively mix media from diverse sources, in diverse forms (multi/cross modal). This poses challenges for ex-

perience and user interface designers and for network architecture design. The attraction of such applications is that they will provide enjoyable ways that help people to nurture valued relationships from the comfort of their own homes. In light of these trends a new niche of games is also emerging: serious games. A serious game is a piece of software that draws from game technology and design principles whilst aiming at a primary purpose other than pure entertainment. Serious games are used or intended for non entertainment purposes including education, corporate and military training, and health care.

3 Future Internet Architectural requirements

New media formats and new forms of interactivity will pose requirements on networks as well as the increasing dominance of content as the main payload of the Internet that will demand a better and more fundamental architectural support for media content handling as well as for building a robust content marketplace.

Furthermore, both user generated as well as commercially produced content will demand a Future Media Internet network architecture that is open for traditional as well as new business models for its storage, adaptation and delivery. Content will be created from a wide variety of devices that range from autonomous, low-end planar sensors to multi-dimensional (ultra) high-definition audio-visual consumer electronics, from fixed to mobile devices. These scenarios will also result in new traffic patterns. The presence and dissemination of content in the network will not only be based on a traditional pull model, but also on variations of publish/subscribe delivery mechanisms. The fundamental architecture must support both open horizontally layered as well as vertical business structures . Design decisions that lock-in only one business paradigm are inefficient economically and should be avoided.

We foresee a Future Media Internet scenario that is based on a content-oriented paradigm, in which each piece of information is coded and indexed by keys and where access to said content may be controlled by the use of identities. All nodes, especially the edge devices, are at the same time caches of content, indexes and buffers. Both overlay content forwarding (evolution of today's peer-to-peer), network protocol enhancements (to better support ad-hoc and delay tolerant networking scenarios) as well as transport technology enhancements (allowing full utilisation of fiber optics capabilities and cross-layer optimisations and network coding esp. in wireless environments) will likely be present at the same time to realise the vision of Future Content Networks. The Future Media Internet must unify in a common architecture these principles of a content-oriented paradigm.

In more details, from a networking point of view the Future Media Internet should:

- Be designed to support tussle; it should be able to support a range of different business models base on flexible virtual dynamically scalable topologies that enable a digital content marketplace that allows for a continuous interchange of buyer and seller roles with traditional end-users and digital content producers.

- Offer accountability on a content level; the extent to which an underlying network resources are used by content on its path to a customer should be understood. With such innovation a greater range of business models for media delivery can be used and the market for content delivery can be more liquid and flexible. Such attributes will lead to an innately equitable value chain, reduction of costs, de-risked investments and the accelerated commoditisation of content. These attributes is expected to drive down the costs for end users.

- Include content aware nodes, able to handle content objects in a generic fashion and offer, search, storage, different types of distribution (e.g., push and pull), ma-

nipulation (e.g., enrichment, scaling and adaptation), protection, and authentication of distributed media content objects as inherent network based capabilities.

- Evolve to higher speed networking technologies, supporting end-to-end streams in the Gigabit range, new more symmetrical traffic patterns, delivering more simultaneous streams and services to the increasing number of network enabled devices both at home and on the move to support an increasingly edge based distribution of content.

- Offer different levels of security, supporting both authenticated as well anonymous access as specified by the content owner. Content services should be manageable by content owners, and allow, for example, content removal.

- Be end-to-end seamlessly adaptable and flexible taking into account the social consumption patterns and users communities, for adjusting the network protocols and optimising the personalisation of content in real-time, the network and terminal-awareness according to the user context, and the configuration of the logic network topology,

4   Conclusions

The current Internet, though widely used for content and communication must evolve to be more capable of dealing with emerging forms of content and of content consumption.   We call this new Internet the Future Media Internet. Changes in globalization, demographics, lifestyles and economics as well as new business models, demanding educated consumers and media literate prosumers are the major driving forces for this transition. In time, free view-point high definition (3D) video and immersive sound, augmented with visual sensors, haptics, olfactory and shared data devices will bring to the mainstream applications that now lie in the area of science fiction.

Five key characteristics of this Future Media Internet are identified as:

- Being designed for tussle

- Offering accountability for resource usage

- Being more content and context-aware

- Supporting more symmetrical data throughputs of Gigabits at the edge.

- Offering secure, manageable and context-sensitive content services

To achieve this Future Media Internet both incremental and breakthrough innovations are required in a range of disciplines in both technical and business domains, across the whole lifecycle of media production.

List of contributors

Name	Organisation	Project	Domain
Norbert Niebert	Ericsson	4WARD	Network
Theodore Zahariadis	Synelixis	SEA	Content
Jean-Dominique Meunier	Thomson	4NEM	Content
Pierre Yves Danet	Orange/France Telecom	4NEM	Content
Federico Alvarez	UPM	SEA	Content
Guillermo Cisneros	UPM	SEA	Content
Ebroul Izquierdo	Queen Mary University of London	PetaMedia	Content
Petros Daras	CERTH/ITI	Victory	Content
Andrew Oliphant	BBC		Content
Jari Ahola	VTT	P2P Next	Content
Robert-Paul Berretty	Philips	Content	Content
Carmen Guerrero	UC3M	Content	Content/Network
Peter Stollenmayer	Eurescom	TA2	Content
Doug Williams	BT Innovation	TA2	Content
David Kennedy	Eurescom	EIFFEL	Networks
Sergio Gusmeroli	TXT	COIN iSURF	Internet of Things
Fidel Liberal	University of the Basque Country	Adamantium	Networks
Harilaos Koumaras	NCSR Demokritos	Adamantium	Networks
Eleni Patouni	University of Athens (UoA)	E^3	Networks
Costas Polychronopoulos	University of Athens (UoA)	E^3	Networks
Nancy Alonistioti	University of Athens (UoA)	E^3	Networks
Alex Conconi	TXT	PlayMancer	Content
Aiko Pras	University of Twente	Emanics	Networks
Jean-Charles Point	JCP-Consult	mobithin	Content