

## CONVINcE

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### Partners:

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GreenSpector, France

EXFO, Finland

Harmonic, France

Institut Mines Télécom, France

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[www.celticplus.eu/project-convince](http://www.celticplus.eu/project-convince)

<http://convince.wp.tem-tsp.eu/>

## Consumption Optimization in Video NETworks

CONVINcE addresses the challenge of reducing the power consumption in IP-based video networks with an end-to-end approach, from the headend where contents are encoded and streamed to the terminals where they are consumed, embracing the Content Delivery Networks (CDN) and the core and access networks.

### Main focus

The ICT carbon footprint is expected to exceed carbon footprint of air travel by a factor of two before 2020 and Internet traffic is definitively driven by video. Furthermore, should people not be convinced of the necessity to reduce carbon dioxide emission, they will need to react to the economic aspect of the problem coming from the increase of the price of electricity which will for sure increase in the future.

Optimizing and reducing the end-to-end power consumption in IP-based video distribution networks from the headend to

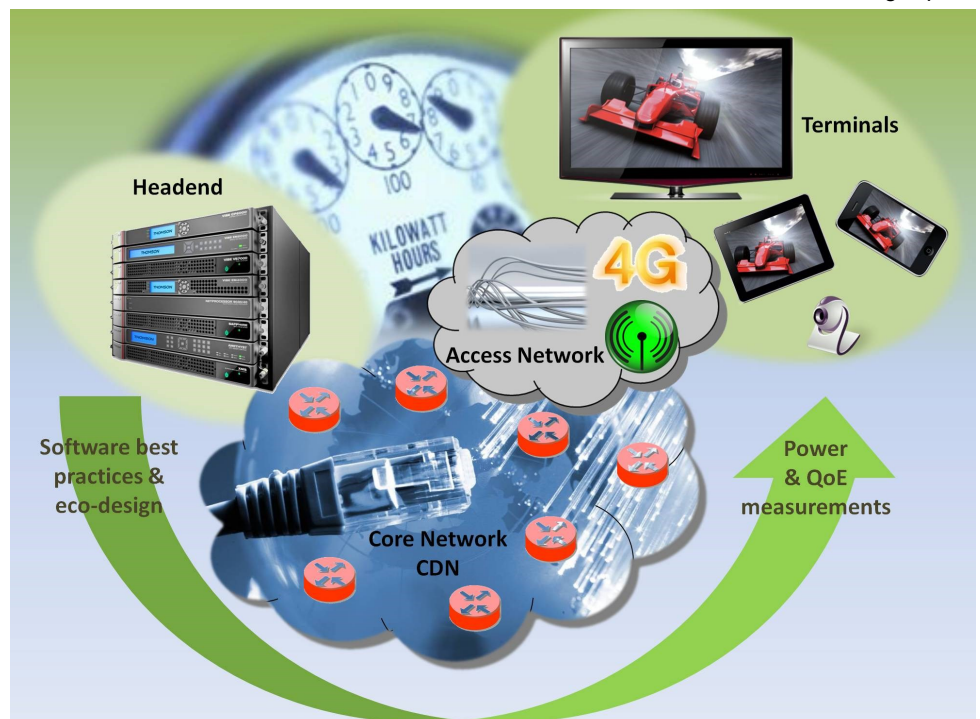
the terminal is the main focus of the project.

The project addresses a wide range of areas and technologies encompassing the following components and functionalities:

- ◆ Video encoding and transcoding,
- ◆ Adaptive bit streaming,
- ◆ Core/metro networks,
- ◆ Access networks, 4G
- ◆ Content Delivery Networks (CDN),
- ◆ Routing protocols,
- ◆ Software Defined Networks (SDN),
- ◆ Set Top Boxes (STB),
- ◆ Fixed and mobile terminals.

### Approach

Partners' efforts concentrated on architectures, hardware and software design, pro-



protocols and basic technologies in the devices. In parallel to these activities, the project ran transversal activities on “Software best practices & Eco-design” and “Power & QoE measurements”. The project also considered the use of new technologies in the form of Software Defined Networking (SDN) associated with Network Function Virtualization (NFV).

The CONVINCe project was built on three strong pillars (so-called work packages) investigating power saving in the headend, in the networks and in the terminals. In order to ensure an end-to-end approach for energy saving, another work package was fully dedicated to system architecture, power optimization & related business cases. Results coming from these four work packages provided inputs to a fifth one in charge of building demonstrators and developing new tools for QoE and power measurements. Finally, results of the project were disseminated and exploited through standardization, publication and demonstration activities.

Three architectural solutions were studied in the project: non-cloud-based architecture, edge-cloud based architecture and SDN/NFV based architecture.

## Main results

With regard to business models, real data has been used from ex-

isting network in France and extrapolated to Europe. The order of magnitude of the savings brought by techniques explored by CONVINCe is some hundreds of millions Euros per year in Europe (90 m€ for IPTV and 660 m€ for OTT, respectively 13% and 14% savings at service level). Using a cloud architecture showed slightly lower figures (80 m€ for IPTV and 620 m€ for OTT), which is compensated by the flexibility brought by a cloud architecture.

Video encoders are the main contributors to headend energy consumption. Applying different techniques studied by the project (e.g. algorithms optimization, use of GPUs or edge-cloud transcoders) can reduce energy consumption by a factor of two. It was also demonstrated that using last-generation encoding technology (HEVC) increases the consumption of encoders by 50%, but end-to-end consumption is reduced significantly, especially in the network area, as the bitrate is also divided by 2.

Several solutions were studied to reduce the consumption in networks. A gain of 10%-15% was achieved by using an all-optical core network. Using DOCSIS3.1 appliances for cable network nodes and amplifiers provides up to 45% improvement. Energy-efficient routing algorithm for SDN-

based access networks can save up to 10% and load balancing algorithm in SDN-based data center networks up to 40%. Virtualized multi-tier architecture brings up to 93% savings in video surveillance networks. Further potential savings were discovered in CDNs and WiFi access networks.

CONVINCe identified also potential energy savings in terminals. Video playback power consumption can be reduced by 83% with optimized execution environment in terminals. Virtualized offloading (saving up to 32%), fountain coding (22%) and radio resource management (15%) can also reduce terminal power consumption. The highest savings in TV displays (45%) is provided by including new optical film structure, LED efficacy improvements and auto-dimming algorithms. Finally, encrypted communication and network interface selection can give extra reductions.

## Impact

Impact of CONVINCe is quite high.

- ◆ Sixteen new products emerged from the work done by CONVINCe partners. Fifteen to one hundred of existing products benefit from the results of the project, most of them been mobile terminals.
- ◆ Two patents were filed by partners during the course of the project.
- ◆ CONVINCe project contributed to four different standardization forums: 3GPP, IEEE, IETF, and MPEG. In these forums the project contributed to 6 different working groups with 38 technical contributions.
- ◆ Partners have published 52 scientific papers out of their activities in the project. The papers were published in high-ranked international conferences, journals and workshops. Another important publication result of CONVINCe is in form of a book that will be published by SPRINGER International Publishing AG. The book title is “Guide to Greening of Video Distribution Networks – Energy-Efficient Internet Video Delivery”. The book contains a number of eleven book chapters, where project partners report the obtained results.

## About Celtic-Plus

Celtic-Plus is an industry-driven European research initiative to define, perform and finance through public and private funding common research projects in the area of telecommunications, new media, future Internet, and applications & services focusing on a new „Smart Connected World“ paradigm. Celtic-Plus is a EUREKA ICT cluster and belongs to the inter-governmental EUREKA network. Celtic-Plus is open to any type of company covering the Celtic-Plus research areas, large industry as well as small companies

or universities and research organizations. Even companies outside the EUREKA countries may get some possibilities to join a Celtic-Plus project under certain conditions.

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