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Setting the future media services architecture

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Setting the future media services architecture

The media industry is in a significant state of change, with new players entering the market, exponential growth of media content, and shifting user consumption patterns. A well-designed media architecture that leverages ICT evolution will enable the media industry to meet the demands of the Networked Society, offering opportunities for all players in the media value chain.

ÅKE GERDFELDTER, PAUL HIGGS, PER LJUNGBERG, NILO MITRA AND MATS PERSSON

Like many others, the media industry can benefit from the efficiencies and savings of an ICT transformation – taking advantage of commercially available IT systems, networking equipment, and cloud-based services. As we move deeper into the Networked Society, media production and consumption will take on a more prominent role in shaping requirements related to network design and performance.

But just what is it that requires media architecture to undergo such a transformation? To start with, the proliferation of OTT solutions that carry content directly to users has led to new consumption patterns, as people shift away from watching scheduled programs to viewing content when it suits them. In addition to changing consumption behavior, the abundance of content is causing media traffic carried by IP networks to rise. The ability to deliver content through a cloud-based service rather than as part of a vertically integrated system has led to more efficient and scalable media delivery solutions, as well as an increase in the popularity of media-based services, with greater demands to deliver content customized to the user's anytime, anywhere environment.

These are just some of the changes taking place in the media landscape, causing architects to rethink their approach to designing solutions for more users, more content and more efficient delivery.

Media industry trends

Traditional business models in areas from content creation to distribution and consumption are changing the face of television, or more broadly, media entertainment services.

Subscribers are consuming greater quantities of data, largely fuelled by increased viewing of online video. Video-centric experiences are becoming more central to people's interactions; users have more devices, a wider range of devices, and view content for longer. People are personalizing experiences to match their current environment in terms of mood, location, time of day, and so on.

New devices with larger and higher-resolution screens have caused a rise in the number of streams delivered using both fixed and mobile access, as well as an increase in the average bitrate per stream.

Today, there is an almost unlimited variety of content and information available for public consumption. How media consumers, Millennials in particular, watch video is changing, moving away from scheduled TV to consuming content when it suits them, and from a much wider variety of sources like YouTube and Twitter, as well as media embedded in almost any digital stream – such as a blog or social platform. Traditional broadcast TV is increasingly being viewed in catch-up mode, forcing industry players to rethink traditional business models based on advertising.

The proliferation of video-capable devices, editing suites, and platforms that enable instant upload and dissemination of content have also changed people's behavior: from primarily being consumers of content to also being producers of content. Portals like YouTube provide a simple means to share content, with increasing capabilities to create semiprofessional quality videos, as well as providing revenue sharing and analytics. The resulting massive growth in content from both new and previously existing sources, together with the ubiquitous nature of search, has created a shift in traditional television electronic program guides (EPGs) from being time- and channel-based to being more interactive. Today's EPGs, more aptly called interactive program guides (IPGs) are enhanced with recommendations derived from personal preferences – moods, social trends, and viewing habits – making the overall media experience a richer and more personalized one.

BOX A Terms and abbreviations

ABR	adaptive bit rate	MPLS	multi-protocol label switching
CDN	content delivery network	OTT	over-the-top
HTTP	Hypertext Transfer Protocol	SaaS	software as a service
HEVC	High Efficiency Video Coding	SDI	Serial Digital Interface
ISP	internet service provider	SDN	software-defined networking
MPEG-DASH	MPEG – Dynamic Adaptive Streaming over HTTP	STB	set-top box
		VoD	video on demand

The rise in consumption of content using OTT services places new capacity and performance demands on the IP infrastructure, and has led to the creation of technologies such as HTTP-based adaptive bit rate (ABR) and improved encoding techniques that are converging on a few standards, including MPEG-DASH and HEVC/H.265. The combination of these techniques, hardware adapted for media processing, a wide range of new types of devices, falling storage costs, higher broadband speeds and other cost/performance gains has resulted in video distribution and consumption appearing in many new environments.

Cost-efficient IP-based networking offers a replacement to the traditional method of connecting equipment in media production and distribution centers with SDI-based coaxial cables. Already today, content producers can provide a broadcaster with video and other forms of pre-edited material as standardized files over IP connections, instead of tape cartridges delivered by truck. Within a production facility, content, distributed over an IP network in a well-defined format, can be edited, transformed and stored using increasingly standardized equipment, moving away from vendor-specific formats and tools.

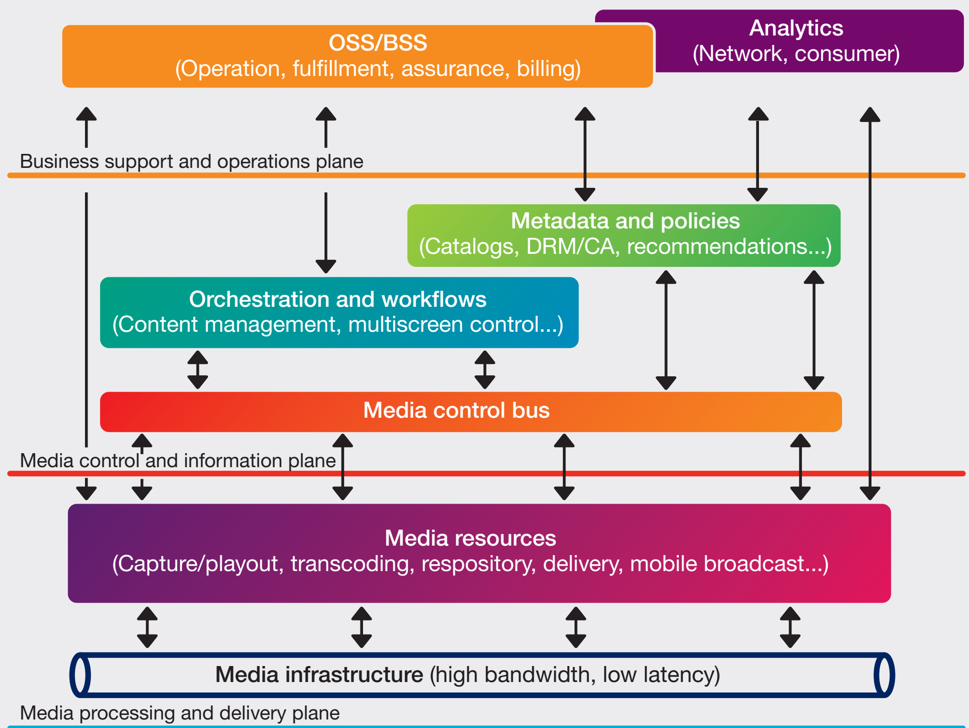
The market conditions that these trends – content growth and viewing patterns, mobility, ICT transformation and new business models – create has led to the need for an open media architecture that can accommodate new technology in a flexible way and enable an all-IP based media ecosystem.

Architecture

An end-to-end media architecture allows multiple vendors and solution providers to integrate their offerings in any part of the media value chain, without disrupting or degrading overall solution capabilities.

Such an architecture is critical to maintaining a viable media ecosystem, and while no single organization can fully define all of its aspects, the exercise of creating such an architecture has shown that taking advantage of the ongoing transformation in ICT to manage market evolution results in more efficient and scalable solutions for all actors in the media value chain.

FIGURE 1 **The media services architecture**



The media services architecture Ericsson has designed uses a component-based model. The resulting environment is loosely coupled; deployment- and integration-time-aware with self-contained functional components that are flexible (easy to replace or update) and reusable. Control is carried out through orchestration and workflows that determine which functions to invoke and when to invoke them in the content distribution and delivery process.

The media services architecture is partitioned into three different planes for separation of concerns, with each plane hosting one or more functional components, as shown in **Figure 1** and described in more detail in **Box B**.

Business support and operations

The top plane of the architecture contains the functional components that manage business flow as well as the operation of media services. Included in this plane are OSS/BSS functions that support operation, fulfillment, assurance and billing of the underlying media functions and services, as well as functions to provide network and consumption analytics.

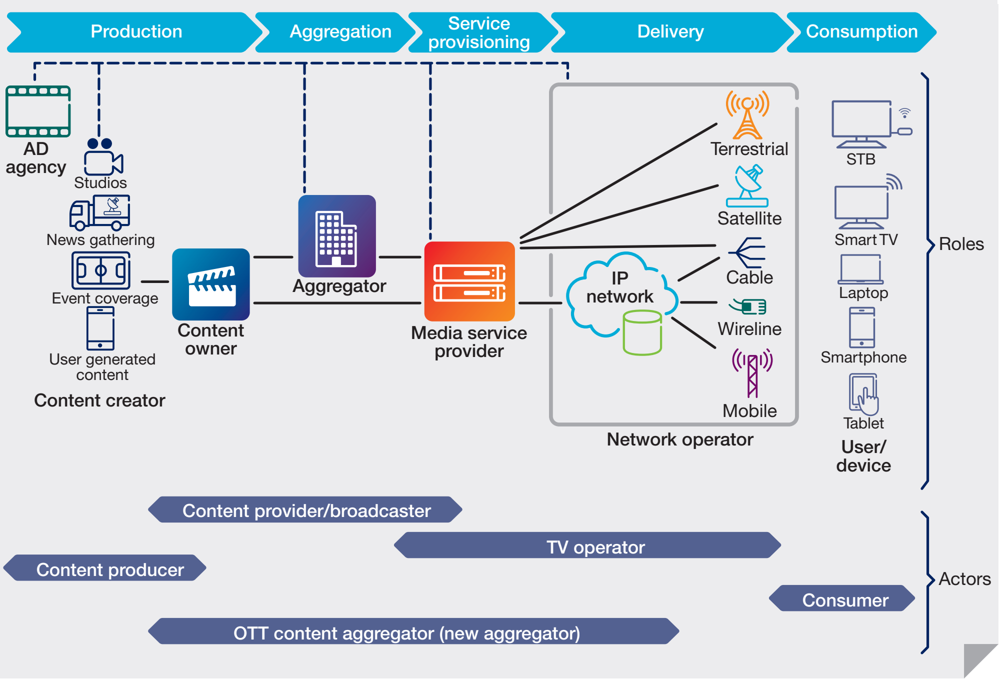
Media control and information

This plane contains the functional components that orchestrate media flows, holds the metadata and policy information to describe them, which is in turn used to guide orchestration. These components are key functions of the architecture. They enable much of the network configuration to be automated, provide abstraction from details, and control the media flow from creation to consumption. Orchestration components are data driven, using network data, policies and metadata, which can be predefined or carried with the content, to manage the full life cycle of a TV or VoD service.

Media processing and delivery

This plane contains functional components that operate directly on media resources such as transcoding, »

FIGURE 2 The end-to-end media services value chain and associated roles



storage and streaming – all of which are connected by a media IP infrastructure.

The components of each plane are defined as virtual functions so that they can be deployed in a cloud environment. The component-based architecture, together with well-defined interfaces between the components, enables the deployment to be distributed, with some components residing in a private cloud communicating with others deployed in a public cloud (or another private cloud). Legacy non-cloud functional components are also supported, but are not dynamically scalable, as they lack the elasticity provided by a cloud infrastructure.

The orchestration and workflow functions, which are central to the deployment of this architecture, control which media resources to invoke in the media flow via the media control bus. This approach provides a flexible abstraction toolkit for the rapid creation of services in response to new demands, such as the automated deployment of a new TV channel or VoD service.

In simple terms, content flows through the media services architecture by first entering the media infrastructure as IP packets and then, subject to orchestration workflows, makes its way from one media resource function to another for transcoding, storage, and other media operations before finally being delivered to the user device for consumption over IP, or as a traditional broadcast.

Roles and actors

The media architecture supports a media services value chain from an end-to-end perspective, which can be divided into a set of roles and actors, as illustrated in **Figure 2**.

As shown in Figure 2, the media services value chain consists of five phases: production, aggregation, service provisioning, delivery, and consumption. To perform their tasks, actors within this chain may take on one or more of the defined roles, with actors in each role performing a specific set of functions – detailed in **Box C**.

The first phase of the media services value chain is production. During this phase, producers, such as movie studios or production companies, create, edit and package content into commercial offerings. The roles related to this phase are content creator and content owner. Producers can be both content creator and owner for their material – which tends to be the case for movie studios. Or a producer may contract out the production and distribution of material while retaining ownership rights – coverage of a professional sports league, for example, often falls into this category. On the basis of a business agreement, a content owner contracts out distribution to an aggregator or a media services provider.

Aggregators, typically broadcasters, movie aggregators and sports networks, purchase content rights from

BOX B Roles and actors

OSS/BSS: handles the operation, fulfillment, assurance, and billing of media functions and services.
Analytics: collects, processes, analyzes and visualizes data available from all the functional components for use in network routing control, content recommendation, ad placement decisions, business management, and network planning.
Metadata and policies: provide information services to other functions, such as content catalogs and program guides; subscriber and subscription data, including entitlements; and content recommendations.
Orchestration and workflows: provide functions to control content processing and service control of the media flow from ingest to delivery, as well as life cycle management and chaining of the functional components.
Media control bus: the integration framework that provides a lightweight communication framework, including a resource manager for proper resource allocation, SLA management, and security functions.
Media resources: perform processing such as encoding, transforming, storage, caching and distribution of the media content.
Media infrastructure: an IP framework optimized for transport of large volumes of content with high bandwidth and low latency.

the content owners, and compile the acquired content into commercial bundles comprised of live feeds, such as traditional TV channels or off-line content such as films or TV archives. These bundles can then be made available for purchase and distributed to media service providers. Advertising slots, bought by media agencies, can also be introduced into content by the aggregator.

Media service providers operate in the service-provisioning phase, packaging and offering acquired content as services to consumers – either as a part of paid subscriptions, as free over-the-air broadcasts or on a pay-as-you-go basis. Content is offered to consumers through a multiscreen portal, which also provides recommendations, detailed program information, and mechanisms for purchase and payment, as well as a means to select the content to be viewed or recorded. Media service providers offer Pay-TV services to consumers through subscriptions, while paying carriage fees to broadcast channel aggregators for their content. Traditionally, some media service providers have also played the role of network operator, providing managed networks – such as cable, fiber, or DSL – for the delivery of their services.

New entrants to the media-service-provider arena offer OTT services directly to consumers with no association to a specific access network, but instead rely on the consumer's existing ISP for delivery of content, leveraging global CDNs. Such media service providers may pay network operators for delivery assurance.

Packaged content is delivered to consumers via a network operator using cable, satellite, terrestrial, mobile or wireline access networks, in exchange for usage and/or subscription fees or as free-to-air broadcasts. Network operators may, subject to agreement with a media service provider, ensure delivery of content with QoS guarantees by applying technologies like unicast, multicast, broadcast, ABR and caching networks.

Users – which may be an individual, a household, a hospitality service (hotels and events), or an enterprise – consume media services over connected devices. Consumers can view content as free over-the-air broadcasts or as Pay-TV content from media service providers in exchange for subscription fees and/or fees for on-demand viewing. Viewing can be multi-platform (Android, iOS, RDK, and so on) and multiscreen on an STB , smart TV, smartphone, or tablet.

BOX C Role definitions

Ad agency: performs media advertising buys on behalf of a brand (advertiser).
Content creator: performs live event capture, movie and TV show creation, and post-production of video content.
Content owner: stores and archives content as well as generating metadata to describe it.
Aggregator: performs functions like translation, dubbing, encoding, compression, quality control, digital rights application, and watermarking.
Media service provider: performs packaging of content into suitable delivery formats to support ABR, and applies content protection to premium content before delivery. Advertisements may also be inserted or replaced in the media content as part of the packaging process.
Network operator: ensures delivery of content with QoS guarantees by applying technologies such as unicast, multicast, broadcast, ABR, and caching networks.
User/device: provides the media client used for content consumption.

Applied architecture

When the roles and the media architecture are brought together, the result – as shown in Figure 3 – is an applied architecture design, with each role instantiating a portion of the media services architecture. In addition, some roles share selected media resources, such as transcoding and storage, with other roles. In cases where an actor performs multiple roles, a single instance of such a resource will suffice. Implementations of the media services architecture will take full advantage of functions and infrastructures that are delivered as services rather than as features of vertically integrated systems.

The network operator provides media delivery over different network types (such as cable, satellite, and mobile). The network that the media service provider selects depends on both business and technical considerations, such as subscription data, type and location of device, and network capabilities. Individual networks are further optimized with technologies such as caching, multicast and mobile broadcast. The network operator has no explicit control plane, as the control information is carried over the media plane in terms of manifest files for ABR-based delivery and decryption keys for terrestrial or satellite delivery.

Deployment architecture

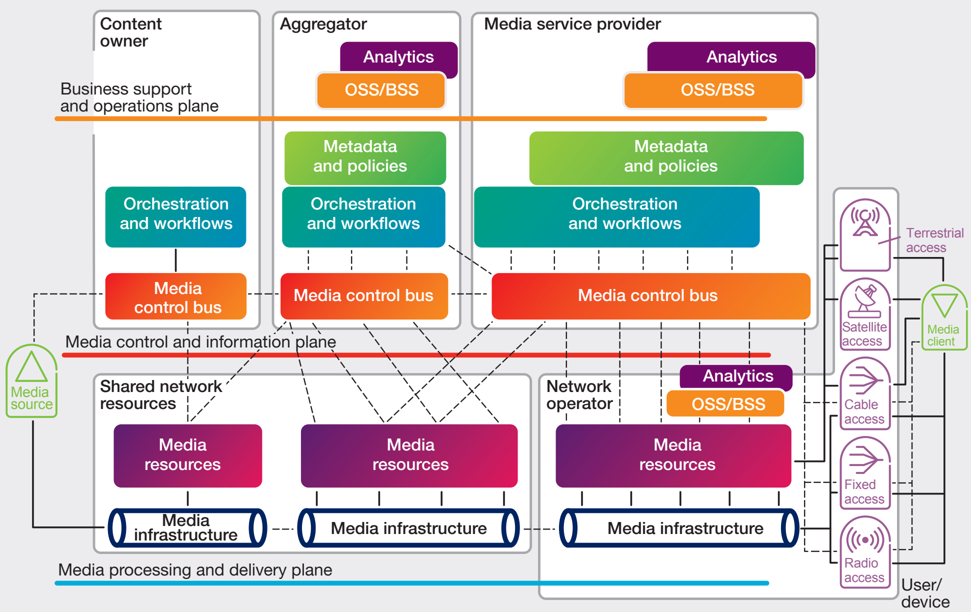
The deployment architecture – the physical instantiation of the applied architecture – is based on a cloud infrastructure.

Actors are likely to have their own private, public or hybrid cloud instances for hosting media architecture functions. In the example deployment architecture illustrated in Figure 4, the broadcaster operates a private cloud for many media functions but also uses a SaaS offering in a public cloud for transient tasks like transcoding and for static functions such as media storage. TV operators have a similar setup and can exchange content more efficiently if their SaaS instances are deployed within the same data center. In the example illustrated, the SaaS provider has no media control and information plane, nor a business support and operations plane. However, it is equally feasible in a SaaS model to provide all layers of the media architecture, in essence offering the whole media architecture as a software service.

The IP-based media transport leverages an SDN-controlled infrastructure[1], in which the IP networking characteristics of layers 2 and 3 are dynamically configured and reconfigured to suit the needs of the media transport between resources. Content is either packaged as files, mainly for on-demand content, or as streams for live or linear content. Both cases are managed and individually optimized for cost and efficiency.

Cloud data center interconnections within and between different actors create requirements for secure and

FIGURE 3 **Media services applied architecture**



efficient connections. The physical interconnections between clouds are typically carried by an MPLS VPN connection, set up to fulfill, for example, the necessary requirements in terms of bandwidth and latency.

Media resource functions often handle large volumes of media content, which places specific requirements on the cloud environment for storage (petabyte capacity and high I/O bandwidth), IP infrastructure (high bandwidth and low latency), and potentially hardware-accelerated transcoding based on graphics processors or dedicated hardware.

An all-IP world

An all-IP architecture requires transport protocols to be transformed to IP. In production and distribution environments, both baseband (uncompressed raw video format) and slightly encoded and compressed, but still production quality, mezzanine formats (for example, SMPTE 2022:6 and JPEG2000-based mezzanine formats respectively) will be encapsulated and carried over IP networks, replacing existing SDI transport. Baseband formats are primarily applicable to post-production, while the mezzanine format is used for further distribution. Baseband and mezzanine formats carried over IP transport will need to be transformed for delivery over traditional non-IP-based broadcast networks. Even for further IP-based distribution, media in these formats will need to be transcoded for ABR delivery.

Delivering content to consumers over IP is rapidly becoming standard, as providers of OTT content promote technologies that offer better user experience and network efficiency. The media services architecture enables a highly scalable, robust, secure and efficient environment for the delivery of live/linear TV and VoD content to consumers connected via fixed or mobile IP networks. Providing optimized service delivery is enabled through a unified delivery mechanism that delivers content to users over all access networks, including IP unicast and multicast of fixed and adaptive rate streams, and broadcast over LTE and Wi-Fi networks.

With the owners of 15 billion video-capable devices eager to consume content over new access technologies like 5G, a need will arise for a media-centric IP-based transport protocol to overcome the limitations of protocols developed for information exchange purposes (such as: e-mails, instant messages, and images), which are less suitable for the always connected, always streaming Networked Society.

Conclusion

Media production and consumption is a fundamental aspect of the Networked Society and will shape requirements related to network performance, and provide new business opportunities for all actors in the media services value chain.

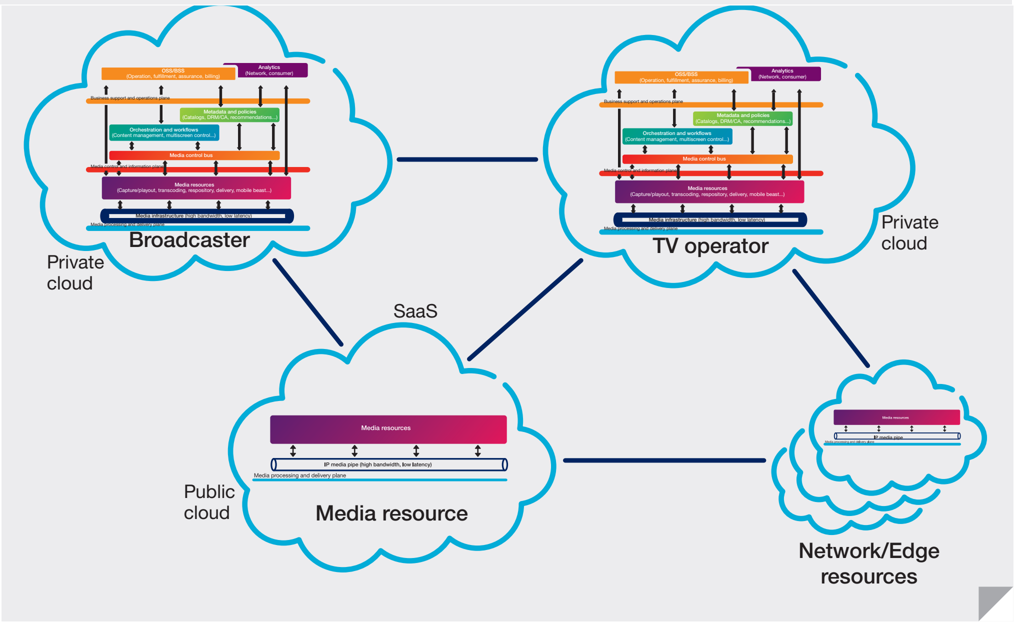
The changing environment created by OTT players, with consumer behavior shifting from scheduled programming to on-demand viewing, creates new requirements for tomorrow's media architecture.

Meanwhile, the media industry is transforming, benefiting from the use of commercial IT-based functions and infrastructures that enable media services to be delivered as cloud-based services rather than as features of vertically integrated systems.

Creating media offerings based on the architecture described in this article brings advantages for both media service providers and their peer network operators, allowing new services to be introduced without changing upstream processes or disrupting services that are already in operation. Such offerings include network-based digital video recording, personalized advertisement insertion and transparent internet caching, which can be implemented on the same media processing and control planes, yielding service differentiation.

Implementations derived from this media architecture will leverage ICT industry technologies, with products and solutions that are component-based, cloud-deployable, and all-IP to provide a scalable and open ecosystem for multi-vendor component integration.

FIGURE 4 **Example of media services deployment**



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Åke Gerdfeldter

is an expert in messaging and multimedia at the Media Systems & Technology unit, Solution Area Media, Business Unit Support Solutions. He joined Ericsson in 1986, working with messaging solutions as a developer and chief architect. He holds the patent for Ericsson's enriched messaging architecture described in Ericsson Review 2007:02. More recently, he has worked with system studies for media products such as the Multi-service Proxy and the Media Delivery Network solution, as well as coordinating the definition of the overall media architecture.

Paul Higgs

is a senior specialist in media technologies at the Media Systems & Technology unit, Solution Area Media, Business Unit Support Solutions. He currently works with media technology innovation and standardization within various television and media-related standards organizations such as the HbbTV Association, W3C and RDK Management. He joined Ericsson in 1992 and has held several positions including technical sales, product engineering and R&D.

Per Ljungberg

is head of the Media Systems & Technology unit, Solution Area Media, Business Unit Support Solutions. He joined Ericsson in 1990 and has worked with software development and systems architecture for mobile systems (GSM/UMTS) in R&D positions in Stockholm, Sweden and at Ericsson Eurolab in Aachen, Germany. In his current role, Ljungberg is responsible for system studies of media delivery optimization in wireless systems, Ericsson's media systems architecture, and technology studies related to all aspects of the media delivery chain. He holds a M.Sc. in computer science from the Linköping University, Sweden.

Nilo Mitra

is an expert standardization architect for media solutions at the Media Systems & Technology unit, Solution Area Media, Business Unit Support Solutions. In his current role he coordinates Ericsson's participation in various media-related standards organizations. He serves on the board of the HbbTV Association, and was a founder of the Open IPTV Forum. Mitra has participated in many standardization fora including W3C, OASIS, WS-I.org, OMG, ITU-T, ISO and the OMA. He joined Ericsson in 1998, after 15 years at AT&T Bell Laboratories, and holds a Ph.D. in theoretical physics from Columbia University, New York.

Mats Persson

is a senior specialist in systems architecture at the Media Systems & Technology unit, Solution Area Media, Business Unit Support Solutions. Currently, he is working with the evolution of TV and media systems architecture, focusing on overall design, analytics and BSS/OSS integration. He joined Ericsson in 1988, and has previously worked with system management in telecommunication services, mobile systems, service layer and service enablement platforms. He holds an M.Sc. in computer science from Linköping University, Sweden.

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Editor:
Deirdre P. Doyle
deirdre.doyle@jgcommunication.se

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Carola Pilarz

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Claes-Göran Andersson

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Ericsson
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Phone: + 46 10 719 0000

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