ANALOG DEVICES

Designing IPTV Set-top Boxes Without Getting Boxed In

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Emerging Internet Protocol TV (IPTV) set-top boxes constitute a rapidly evolving and fluid product category. Market forces and available technologies are driving multiple variations on the concept. Some business models call for video on demand (VoD) and multicast TV; others bundle TV with voice over IP (VoIP); many require Internet browsing.

Set-top box designers are also being asked to support an array of new audio, video and image formats as their products take on the attributes of more open, network-connected appliances. IPTV set-top boxes may be enabled with the functions of personal video recorders (PVR), digital media adapters (DMA), voice over IP (VoIP), videophones and more.

While based on a shared foundation of media processing and network processing, each type of additional functionality layers on different requirements. Entertainment services such as IPTV and VoD depend on streaming media over a wide area network (WAN). Localized media applications such as PVR and DMA add a media source in the home, which requires that streaming and digital rights management be applied to local area network (LAN) environments. Communications-intensive applications like VoIP and videophone need to run independently and in parallel with streaming media.

What's more, service providers may use IPTV set-top boxes for a base set of services now, with plans to expand into interactive games and other offerings in the future.

Deployment in the real world imposes further engineering challenges. Conditions tend not to live up to their billing: Broadband data rates are variable. Latencies and delays impair two-way communications. Changes in head-end video encoders produce interoperability problems with set-top decoders. Your device may be installed on networks the service provider doesn't control, or in parts of the network that perform below standard, subjecting it to uneven and unoptimized quality of service (QoS).

Added features and future requirements aside, today's IPTV set-box boxes typically have a set of demanding requirements in common. These tasks must be performed in hard real time to provide a desirable user experience:
- receive streaming compressed audio/video over a network
- process the stream containers
- decode the streams
- present a synchronized audio/video output to the listener or viewer

Digital rights management (DRM) protection and conditional access (CA) (which ensures that only authorized subscribers have access to content) are likewise necessary, in order to satisfy media companies and other content owners.

Careful design and architecture choices must be made from the beginning to engineer an IPTV set-top box capable of handling known requirements along with the unknowns that await. A processor that works best with constant and uninterrupted data sources--as in DVD and cable set-top box applications--will prove inadequate and limiting. Starting with a processor competent at both streaming media and network processing will allow you to meet performance and cost targets.

To develop a design that appeals to more potential customers, look for the flexibility to reallocate processor capacity to perform a wider range of functions. A processor that also has low power consumption may even permit extending your base design beyond the set-top, to devices such as portable media players or automotive entertainment units.

After that, a capable and flexible IPTV set-top box depends on informed design choices across three interdependent areas: media processing, network communications and application processing. Doing so significantly improves performance, cost and extensibility.

Do

- **Design for multicast**. Although the network uses IP technology, two-way communications between the set-top and servers on the network is not a given. Multicast TV applications are predicated on the ability of the set-top box to decode what comes, when it comes, without a back channel of communication. And no back channel will be available when your "set-top" is an in-car or portable system that provides satellite TV.

- **Size for peak network load.** Many of today's media processors have limited capacity and efficiency for network processing. The drawbacks include dropped video frames and voice breakup on VoIP calls. Experience shows that what may not be apparent in the lab can become all too clear in deployment, when unhappy subscribers return their set-top boxes because network processing did not keep up with what the WAN dishes out.

- **Predict the unpredictable.** Order and predictability are rare in the field. Network congestion delays content streams, for example. Wireless connections drop. Streaming video, VoIP and bulk data transfers vie for bandwidth, and the user may decide to push each service to its limit simultaneously. When such conditions are unavoidable, the ability to handle interruptions and service degradations gracefully as possible will help differentiate your design from the competition's.

- **Allow a customizable interface.** To allow the set-top box to be widely deployed and accepted, its design must allow the service provider to customize the user interface. Look and feel is key to fitting in with the rest of a product line.

- **Enable field upgradeability.** It's not possible to release a product that includes every existing and future variation of audio and video codec, DRM scheme, media server protocol, and audio/video transport capability. New services must be deployed. Rolling out trucks to perform these upgrades is costly for service providers. Eliminate this deal breaker with software upgrades that can be accomplished remotely over the network.

Don't

- **Assume a constant data rate.** The nature of traffic on an IP network is bursty and backup-prone. Upstream and downstream data rates may not be symmetric, as with ADSL. Judicious use of memory buffers lets you compensate for network jitter, handle audio/video synchronization and separate media from control processing.

- **Assume you'll get all the data.** Though packet loss is characteristic of the network, dropped video frames and sound problems will mar the user experience. Many media systems are designed primarily for a constant, uninterrupted data source environment and can't perform the loss concealment that is a must for both audio (silence insertion, audio signal interpolation) and video (bad packet detection and removal).

- **Expect broadband throughput as advertised.** Counting on a network's best throughput invites trouble because most broadband networks were built for intermittent traffic such as Web browsing, not to carry streaming media. Another rule of thumb is that different segments of the network may perform at different data rates. Encoding content at a lower bit rate than the network's claimed throughput compensates for variations across the network.

- **Use a decoder designed for fixed media.** IPTV set-tops require a decoder designed for communications systems that will inevitably change. Head-end video encoders improve their compression over time by adding new techniques or tweaking current ones, but these changes often cause visual effects in the set-top box decoder depending on the type of content. Remote software upgrades are the only economical way that service providers can reconcile these errors. And new services, such as videophones or Internet-downloaded content, will require new audio and video decoders; software-based decoding provides the best compatibility.

- **Partition processing too rigidly.** Usage scenarios for set-box boxes are evolving. Avoid partitioning your system such that new applications can't use processing power in new ways. For example, a service provider may opt to move from an electronic program guide (EPG) style of information bar to a highly interactive Internet browser. Inflexible partitioning may result in a design that performs well for IPTV, but leaves Internet browsing slow and weak.

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