

**New Embedded Cable Modem Modules Lead the Way to  
Embedded DOCSIS™**

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A new initiative by Cable Television Laboratories, Inc. (CableLabs®), Embedded DOCSIS (eDOCSIS™) is paving the way to a future in which data over cable service interface specification (DOCSIS™) cable modem functionality is embedded in various home appliances such as game-boxes, set-top-boxes and digital televisions. With prices of cable modems dropping dramatically and silicon integration converging to single-chip cable modems, having DOCSIS become a common interface embedded in consumer electronics devices is seen as a natural next step for DOCSIS.

The greatest challenge of eDOCSIS is testing and certifying DOCSIS functionality within the wide range of possible home appliances. It is this certification process that provides cable operators with the confidence that embedded cable modems will not negatively impact their network. It is conceivable that a single misbehaving cable modem can degrade the service of an entire neighborhood by interfering with their upstream transmissions. Indeed, in order to avoid these consequences, most cable operators deploy only cable modems that have passed rigorous certification tests at CableLabs. Applying the same requirement to embedded cable modems is much more difficult. The process that CableLabs uses to test stand-alone cable modems today may not be feasible for embedded cable modems due to time and space parameters. It would be extremely time consuming to test every consumer product or appliance each time the hardware or software requires a revision. And even if CableLabs did, with the high costs and limited schedule of today's certification process this is likely to deter original equipment manufacturers from embedding a DOCSIS modem.

The key to a successful DOCSIS embedding scheme is to find the right balance between the potential device cost savings (as achieved by embedding the DOCSIS functionality vs. the cost of two independent devices) and the consequential system complexity and certification challenges.

This article describes the requirements and potential applications of an embedding scheme that is based on a self-contained embedded cable modem module ('ECM'). Such an embedding scheme, in which the ECM has interfaces that are similar enough to the currently specified stand-alone cable modem, minimizes the changes required in the DOCSIS testing process, and could help accelerate the trend of embedding DOCSIS in as many devices as possible.

A simple yet effective ECM adheres to the following requirements:

1. The ECM is a self-contained cable modem module, which does not share the resources of the hosting system with the exception of power supply.
2. The ECM uses a data packet interface that is similar to Ethernet. Two possible options for this interface include:
  - a. 'Direct Ethernet' which is the signal at the output and input of the Ethernet PHY. It is essentially Ethernet without the magnetics and the connector.
  - b. MII interface which is the interface of the Ethernet MAC on the ECM. This is a digital interface as opposed to the analog interface of the 'Direct-Ethernet', and therefore requires more pins, but relieves the ECM as well as the host circuit from the need to include an Ethernet-PHY.
3. The ECM is fully enclosed in a metal case, which would provide RF shielding ensuring the RF integrity of the cable modem even when embedded in noisy systems.

The ECM described above can be tested in the same way DOCSIS cable modems are tested today and using the same automated set-up. This is done by attaching the ECM to a test board, which completes the Ethernet-like interface on the ECM to a standard Ethernet interface using an Ethernet PHY in the case of the MII interface or only the Ethernet physical connector and magnetics in the case of the direct-Ethernet interface. In both of these cases, the combination of the test board and ECM module is, from a testing point-of-view, a standard DOCSIS cable modem with RF-in and Ethernet-out which is ready to be tested in the existing DOCSIS test environment.

Once an ECM is certified, it should be allowed to be embedded into various devices such as game-boxes and digital set-top-boxes (STB) without additional certification testing. The ECM is completely self-contained, with separate components and separate software. Its hosting system should have no impact on its performance. A potential concern could be that the hosting system will add RF interferences. However, by enclosing it in a metal can, like canned tuners are packaged today, the ECM can be shielded from potential RF interferers in the hosting system.

By certifying the ECM, operators open the way to the inclusion of DOCSIS in a host of new devices. Manufacturers of television sets, for example, who wish to include DOCSIS functionality in their set, do not need to submit twenty television sets for

certification testing, but rather they need only ensure that they use a certified ECM. This makes the design and testing of a DOCSIS-enabled television set much simpler without compromising the high standards of conformance testing that operators rely on today.

The ECM can be embedded in many different appliances. The following are some examples:

**1. Digital STBs**

High-end STBs already include integrated DOCSIS functionality. However, very few of them, if any at all, are actually used today to provide high-speed data service to users. The DOCSIS functionality is typically achieved by using integrated components, that implement both the video demodulators and the DOCSIS transceiver on a single chip, and that share various system components such as memory and CPU. An integrated MPEG/DOCSIS video/data system is very difficult to test, given that the STB software and hardware are constantly evolving. Requiring DOCSIS certification for STBs is a significant burden on STB manufacturers, yet relaxing the certification requirements on DOCSIS-enabled STBs may threaten the operators' network.

A solution to this problem is to decouple the data and the video in the STB by embedding a certified ECM in the STB. This would relieve the manufacturer from needing to submit the STB for DOCSIS certification, and reduce the risk of changes in the STB software, inadvertently degrading the performance of the HFC plant.

**2. Residential Gateways (RG)**

ECM enables RG manufacturers to decouple the RG/Cable Home functionality from the DOCSIS functionality. The RG software will evolve at a faster rate than DOCSIS software, given the continuous advances in firewall and home networking technology. By embedding an ECM into an RG, compared to embedding RG functionality into a cable modem, RG manufacturers can achieve faster time-to-market and provide updated software and hardware revisions without affecting the DOCSIS subsystem and without requiring DOCSIS certification.

**3. Game-boxes**

There is a great deal of interest in connecting game-boxes to a broadband network for online multi-user gaming. Today, users can connect their game-boxes via the Internet using an Ethernet interface or a telephony modem to online gaming services such as Microsoft's 'Xbox Live'. The typical location of a game-box in the home is next to the television set, however, in many homes this is far from a phone-jack and from an RG with an Ethernet port. Using the coax (which is almost always next to the game-box) for broadband gaming access is much more natural. One popular game-box includes an expansion slot, which may be used to house a DOCSIS ECM. Given the large installed base of these game-boxes, the potential market for dedicated DOCSIS online gaming interfaces is huge.

**4. DVD**

A DVD with an ECM could provide various applications such as web browsing, email/messaging using the television display. Today DVDs already have the CPU power to support such basic online services. All that is missing is the modem. The DVD is typically located near the coax outlet making DOCSIS a natural candidate for broadband access. With a broadband connection in the DVD, users can access the various online features that are included in DVD movies. Today these features can only be accessed with a DVD-ROM drive in a connected computer.

**5. PVR**

Personal Video Recording (PVR) systems and their time-shift recording capabilities are posed to be the prevailing apparatus for TV recording in the future. Embedding an ECM within a PVR paves the way to an array of new uses that leverage the PVR storage capabilities – from Video On Demand (VOD) PPV/movie rentals over the Internet to customized storage of webcasts and Internet content.

**6. Digital TV**

The TV, being the most popular device used for video display in the home today, is a natural candidate for embedding an ECM. The processing power inherent in Digital TVs may be used to drive ECM related applications such as advanced Electronic Program Guides (EPGs), Internet access, instant messaging and even video conferencing – all operated through the familiar TV remote-control and displayed on the household TV screen. Having an ECM within the TV enables such applications without the need and burden of establishing a home network.

The devices described above are merely a few examples for new DOCSIS-enabled devices. As the model of ECM is adopted, and gains support from both operators and manufacturers, many new devices will be introduced which will embed a DOCSIS ECM for broadband access. The high volume of ECM will drive costs down, and motivate manufacturers to find new creative ways to include DOCSIS in their products. Cable operators will need to be creative as well with their service offering to make use of the ECMs in the various home appliances. For example, the ECM in the game-box may require a dedicated broadband gaming service that operators can sell independently from their high-speed data services. Such a service, which could be bundled with existing online gaming services, not including the broadband access portion, would represent a significant opportunity for increasing revenue.

The ECM not only opens new revenue opportunities for cable operators, but it could also improve customer retention. With multiple connections in the home to the coax network, and with multiple services using DOCSIS, subscribers would be less likely to switch service providers.

ECMs using Texas Instruments' integrated DOCSIS cable modem chip and software have been demonstrated to be operational and manufacturable. The fully functional ECM is as small as a deck of playing cards.

ECMs will enable the DOCSIS interface to be as easy to integrate into a product, as is an Ethernet interface. Manufacturers will enjoy the time-to-market advantages provided by the ECM, and operators will benefit from maintaining the high level of conformance testing that they have grown to expect from DOCSIS products. As ECMs become popular, manufacturers and operators can and will find new opportunities to produce innovative products and services that utilize the cable network and DOCSIS for high-speed access.

For more information, visit the Texas Instruments Web site: [www.ti.com/cablemodem](http://www.ti.com/cablemodem)

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