INTEGRATING A HOME SYSTEM

It has been about 20 years since manufacturers in the consumer electronics industry started to explore the business potential in home automation. Until then, hobbyists had been jury-rigging controls for various home applications, such as lighting and entertainment. About a billion dollars has been invested in developing networking technologies and components for home systems, yet we are constantly on the verge of significant market growth, but not quite there. Why?

TRANSFORMING DEVICES INTO SYSTEMS

Our homes are replete with devices that improve the operation of the house and make life more convenient, productive, and safer. These devices range from large appliances in the kitchen and utility room to entertainment products to an endless array of small appliances throughout the house. In addition, we have sensors and control devices for lighting, heating and cooling, and security. Each device or group of devices is independent of the others. Consider your routine before retiring at night or before leaving for work:

- Adjust the thermostat for comfort and conservation.
- Make sure the range, oven, and coffee pot are off.
- Turn off most lights.
- Shut the TV, radio, and stereo.
- Set the security system.
- Set the alarm clock for wake up.

Some home systems on the market already offer a master control for the house with single-key functions for "At Home," "At Work," "Asleep," and "Vacation." The manufacturer accomplishes this integration usually with a proprietary network and proprietary interfaces to the device under control.

Figure 1 illustrates a possible home network. The black lines represent the network. The network is built on special data wires or possibly a wireless technology. Each home appliance and device is connected to this home network. The residential gateway brings in cable, DSL, or satellite video and audio, and enables Internet access. Soon we may use the gateway to deliver services from companies that will sell home control and monitoring. For example, appliance companies might monitor kitchen appliances for preventive maintenance to find problems before the appliance stops working.

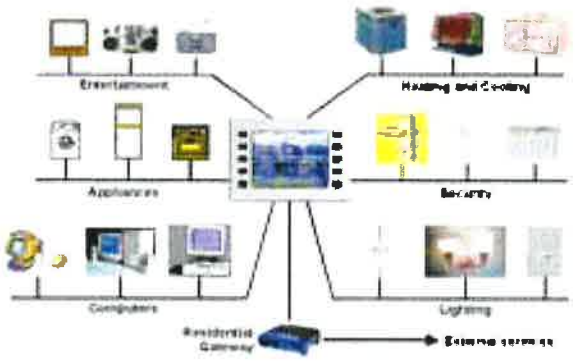

Figure 1 *– An Integrated Home Network*

INTEGRATING APPLIANCES

Integration is the promise of a home network, but the reality is that each appliance operates separately and differently from each other appliance. The industry tried to change this by writing uniform standards for control communications regardless of the medium (wires, wireless, power line carrier, etc.) Examples of such comprehensive protocols are the European Home System, the Home Bus System (Japan), and CEBus (U.S.). All of these technologies worked well, yet they all failed at unifying the industry because:

- Some developers of proprietary technologies actively campaigned against adoption of any standard.
- Appliance manufacturers were confused by the network choices.
- Interconnecting appliances and devices using the same protocol does not guarantee interoperability.

The lack of interoperability among products is probably the most serious impediment to expanding the home systems industry.

WHAT IS INTEROPERABILITY?

Interoperable appliances are designed so that when connected together they perform useful functions. For example, some manufacturers now sell a pair of washer and dryer appliances that communicate settings from the washer to the dryer, as illustrated in Figure 2. This is a start. However, universal interoperability requires communications among products from competing manufacturers. These manufacturers must decide how appliances will

cooperate to serve the user:

- What data is to be communicated?
- How is the data to be communicated?
- What does the data mean?
- What is expected of the recipient appliance in response to receiving this data?

Figure 2 *– Appliance Communications*

ACHIEVING INTEROPERABILITY

The fundamental decisions to support interoperability involve:

- The application: What is to be accomplished and what is the sequence of actions?
- Observability: What can be read remotely?
- Controllability: What can be controlled remotely?

Observability and controllability are new issues for appliances. Until now, the only external user of an appliance was the consumer. Appliances communicate with consumers via a front panel with dials and knobs, and displays. Interoperable appliances communicate with each other via machine-to-machine signals. Such communications must be precise.

Precise communications is defined by an applications language. As with human communications, we need to choose our language structure (the syntax) and the meaning of our words (semantics). For example, messages for one appliance to report temperature to another appliances might be defined by the following parameters:

- The number of digits.
- The position of the decimal point.
- The temperature scale (Fahrenheit or Celsius).

Decisions on observability, controllability, and an application language must be uniform among products to be interconnected. A standards body is an appropriate forum for achieving consensus among manufacturers on these issues. For example, the first step toward interoperability among kitchen appliances was the creation of the American National Standard, CHA-1-2002, by the Association of Home Appliance Manufacturers (www.aham.org). This standard, *Connected Home Appliances - Object Modeling*, employs object-oriented techniques to describe generic models of seven kitchen appliances (as was explained in the *CABA Home & Building Automation* QUARTERLY in Fall 2002.)

INTERNATIONAL STANDARD

An international standard intended to promote interoperability among home system applications is under development. The first part of this three-part standard describes the methodology for accomplishing interoperability. This standard was published in 2004 by the International Organization for Standardization (ISO) in Geneva, Switzerland as ISO/IEC 18012-1, "Guidelines for Product Interoperability, Part 1: Introduction." Copies are available from Global Engineering Documents (http://global.ihs.com).

The tools for describing applications are being developed for Part 2 of the international interoperability standard. A classification of applications, called a taxonomy, will describe models of applications. These models are analogous to block diagrams, but are produced with XML tools. XML was developed for the World Wide Web to organize databases. XML Schema will be used to develop a dictionary of key application functions.

Models of popular home systems, already written and published as technical reports by ISO, will be included in this standard as subsequent parts. These systems include lighting control, security, energy management, and others. Models of these systems will be incorporated into the interoperability standard using the taxonomy and XML Schema from Part 2.

CHALLENGES OF INTEGRATION

Occupants do not have an information technology (IT) manager at home. Therefore, networking must be provided simply and almost invisibly. The following table lists some of the challenges introduced when appliances are networked together.

Integration Challenges
Network Configuration
New Appliance Installation
Provisioning of Services
Customer Privacy
Network Security
Safe & Fail-safe Operation

These integration functions are critical for a home network because:

Configuration and re-configuration

The assortment of home appliances and related devices connected to a home network is not static. Appliances, lamps, and other devices are often added to the network or moved from one location to another.

Service provisioning

With increased embedded software in appliances, it is possible

that vendors will offer consumers appliance upgrades or new features by downloading software changes into the appliances. The term *provisioning* encompasses the steps required for enabling these new features.

Security and privacy

A home network must operate securely and must not facilitate theft of property or loss of privacy. Consumers with a home network connected to the Internet are at greater risk of theft and loss of privacy than a business. (Privacy issues were discussed in the *CABA Home & Building Automation Quarterly* in Winter 2000 and Spring 2001.)

Safe and Fail-safe operations

The safe operation of appliances is primarily the responsibility of the appliance manufacturer. When an appliance can be controlled remotely via a home network and possibly connected to the Internet, intended or unintended signals must not cause unsafe appliance operation. "Fail-safe" means that an appliance continues to operate safely even if the network is impaired and some functionality is lost.

BUSINESS MOTIVATION FOR INTEROPERABILITY

Achieving product interoperability involves considerable re-engineering of appliances for home networks. However, interoperability among products is ultimately a business decision.

Consumers are often urged and encouraged by manufacturers to equip their kitchen or their media room with one brand of appliances. About 20 years ago, audio-video companies introduced components with connectors that were unique to each brand. Components from competing brands could not be interconnected. Consumers rebelled, the products failed, and this practice was abandoned.

In home systems, there have been attempts to corner the market with proprietary communications methods. Such tactics usually fail or end up delaying market growth. Ultimately, it is more profitable to gain a share of a large market than to control a small market. Even if profit margins are squeezed by competition, a growing market affords opportunities to introduce new products with higher initial margins.

Dr. Kenneth Wacks has been a pioneer in establishing the home systems industry. He advises manufacturers and utilities worldwide on business opportunities, network alternatives, and product development in home and building systems. For further information, please contact Ken at 781.662.6211; fax 781.665.4311; kenn@alum.mit.edu; www.kenwacks.com.