Advanced networks **make pinball games Pop!**

Traditional pinball machines are using industrial sensor buses to bring body table games into the 21st century.

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Suppose you traveled back to the year 1982, found a pinball technician at a bustling arcade, and showed him/her a 2015-era pinball machine. The technician would recognize a familiar sight—hundreds of solenoids, actuators, sensors and lights all connected using bundles of discrete wires to a central control system. That's because aside from peripheral device improvements—such as replacing incandescent bulbs with LEDs, incrementally upgrading microcontrollers, and adopting updated score display technologies—the core architecture of pinball control systems has been practically frozen in time since the 1980s. The last big change in pinball design was the introduction of electronics in the 1970s.

Technology has marched on. There has been a recent explosion of pinball machine popularity driven by a new generation of casual players, competitive tournament players and seasoned home collectors. Today, companies are finally re-inventing the core architecture of pinball. The reason: a shift in customer demand from single standardized games to a diverse spectrum ranging from simple casual-play games to complex limited-edition collector games.

For example, pinball machine manufacturer Stern Pinball realized that a varied product line of this sort demanded a different mix of inputs and outputs (I/O). Moreover, Stern could see challenges adapting its 1990s-era fixed I/O count architecture across this new spectrum of products. Simpler games had dozens of unused I/O which drove up unit costs, and more complex games needed expensive I/O additions, lengthening development time and limiting features that designers wanted to implement.

On the other hand, many industries have reaped rewards from modular embedded network architectures. Stern realized that all pinball machines have a similar set of embedded control problems that could be addressed with inexpensive embedded network systems such as CANbus used in the automotive industry. Thus, embedded network systems looked like a way to address problems of cabling complexity, development speed, I/O count flexibility, part obsolescence protection and overall product cost.

This was the environment that gave rise to a pinball control system, dubbed SPIKE. The first game to use it is called WWE Wrestlemania, debuting in early 2015. The pinball control system features a custom embedded network node bus, a custom embedded Linux-based software stack, and a 48-V embedded power distribution system.

Challenges of central control

Pinball has maintained its popularity for decades in part because it is a real game interacting with the real world. This real-world interaction differentiates the game from video games and is a big reason for its most recent resurgence. Reliable, fast and powerful I/O to the game's control system is central to the player experience. Every pinball machine has hundreds of inputs and outputs across a wide variety of devices, sensors and lights.

Historically, pinball machines have employed a central fixed I/O board connected to the primary CPU controlled by a custom microcontroller platform running an in-house operating system. For a variety of reasons that include thermal flow, reliability, vibration reduction and serviceability, I/O electronics have been located in the upper backbox of the game, requiring significant custom wiring harnesses to connect the central I/O board to the playfield devices.

A typical pinball machine I/O mix is quite diverse. It includes 16 to 24 outputs for driving solenoids, motors, electromagnets and other mechanical devices in the game. These devices can draw up to 500 W momentarily and operate at voltages up to 50 Vdc. There is also individually controlled lighting that consists of 64 to 96 individually addressable lights. Recently developed games have switched from incandescent bulbs to