More Secure, Cost-Effective Lighting Control Systems with Content-Centric Networking
Executive Summary

Up to 50 percent of total electricity consumption in office buildings is used for lighting.¹ The worldwide drive to conserve energy and reduce CO2 emissions, as well as legislation to ban incandescent lights, is driving the adoption of low-energy lighting alternatives.

As building lighting systems transition to more energy-efficient options, there is a growing opportunity to provide a secure, robust, and cost-effective way to install, operate, and manage these systems. This document presents a proposition for the design and prototyping of lighting control systems based on PARC’s Content-Centric Networking (CCN) technology. It includes an initial work proposition along with example use cases.

1. Introduction

Lighting systems for industrial, municipal, and residential buildings are increasingly transitioning to energy-efficient alternatives such as light-emitting diodes (LEDs) to reduce costs and environmental impact, as well as comply with energy-efficiency legislation.

Many new lighting control systems are beginning to use an IP-based architecture and functionality but this approach is costly and inefficient. It requires managing and allocating IP addresses, constructing firewalls for security, and managing complex IT configurations. There is also a high risk for security breach to building safety when systems are wirelessly controlled.

We see an opportunity for a new approach to designing and deploying control systems that features enhanced security, intuitive naming, and easy manageability. PARC’s Content-Centric Networking (CCN) technology provides a new communication and architectural model that provides secure, self-configuring, cost-effective, and robust lighting control.

2. About Content-Centric Networking (CCN)

CCN is an alternative approach to the networking architecture based on the principle that a communication network should allow a user to focus on the data he or she needs, rather than having to reference a specific, physical location from where that data is to be retrieved. Among many advantages, CCN enables a simpler configuration of network devices and builds security into the network at the data level. The CCN initiative has continued to gain momentum with an open source code release, Android implementation release, commercial engagements with prominent industrial partners, and the CCN community meeting recently hosted at PARC.

3. The Opportunity

CCN enables the configuration, installation, and management of lighting control systems that can be either a first-mover opportunity for new market entrants, or competitive differentiation for existing companies that are transitioning to modern lighting systems. Either type of company can collaborate with PARC to tap into an expanding market opportunity, and establish itself as a leading player in the lighting ecosystem. CCN can drive top-line growth by enabling customizable control services and applications (see use case scenarios below) with reduced operational costs.

4. Proposition

The proposed work with PARC includes the architecture and design of a lighting control system that uses the security, naming, and device discovery features of CCN. Specific elements of the work may include:

- Design and implement bootstrapping mechanisms that use CCN protocol details for device discovery, maintenance, and association.²
- Outline naming strategies that associate fixtures with intuitive naming mechanisms.
- Prototype and implement using Linux server for control logic implementation and for communication and exercise of policies with lighting fixtures. Commands can be entered from a console that can be a panel or a mobile device depending on industrial or residential settings.
- Implement a mobile interface on an Android device to receive user command inputs that get communicated to the controller, which in turn communicate with lighting fixtures.

Further details of the implementation will be outlined with a potential partner company once goals and objectives are aligned. Further discussion will enable us to create a comprehensive work plan.

5. Application Market Description

This proposition is for software design and implementation of lighting control systems for the residential and industrial markets. It addresses the need for agile, secure, and energy-efficient control systems. The proposition can also be expanded to the more general market of building management systems.

² The NSF-funded Named Data Networking initiative, with PARC and several major U.S. universities as members, has developed and prototyped lighting control demonstrations in an effort led by UCLA.
6. Use Case Scenarios

CCN-based lighting can enable several use cases for lighting control and management. Some example policies could be turning off the lights in the cafeteria after 9 p.m., dimming or turning off the lights in the entire building after midnight, or turning on the room light when prompted in any building by an authorized user. A handheld device can be used to control lighting fixtures in a residential setting. A panel can be used in an industrial setting.

Other uses include emergency response, energy saving, and energy monitoring:

- Emergency scenarios such as fire safety can overrule any existing policies and turn on all the lights in the building.
- Energy-saving mode can be overridden by higher priority rules such as an authorized user turning on a room light at night, or in an emergency.
- The amount of energy consumed can be recorded and monitored to assess efficiency and the implications of a change in lighting policies control.

7. Competitive Positioning

Several global players are either planning or have introduced products for digital lighting control systems designed to optimize energy consumption. CCN differentiates from existing solutions in the following ways:

- Content-based security creates a secure and robust system immune to breach even as handhelds are used to control lighting systems.
- The cost of installation is reduced due to the bootstrapping, plug-and-play, device enrollment, and configurability features.
- The operational expense of maintenance and troubleshooting is lower than traditional IP-based control systems.
Next Steps

Over the years, PARC has developed a roadmap for defining projects in a way that maximizes the likelihood of success.

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<tr>
<th>Status</th>
<th>Step</th>
<th>Outcomes</th>
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<tbody>
<tr>
<td></td>
<td>PARC Introductions - Business Model - Technology Opportunities</td>
<td>If Client believes further exploration is warranted, select one to three areas to focus on for further exploration</td>
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<td>Overview of Client’s Strategic Interests and Current Capabilities</td>
<td>Client provides overview of strategic priorities, internal capabilities/resources. PARC and Client determine areas for further investigation.</td>
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<td>Project Formulation</td>
<td>PARC and Client’s internal stakeholders design ways to address Client’s strategic priorities. Usually includes technical and business case development.</td>
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<td>Validation</td>
<td>Executives at both Client and PARC agree that the direction outlined is of mutual interest. Although there is no commitment to enter into a contract, each company’s executives have reviewed the high-level project and commit to further development of the proposal.</td>
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<td>Detailed Proposal Development</td>
<td>Client and PARC team members refine a detailed Statement of Work to achieve desired business results. This includes development of mutually acceptable terms and conditions.</td>
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<td>Contract Development</td>
<td>After the business and technical parameters have been established, PARC translates these into a Project Agreement for legal review.</td>
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<td>Program Delivery</td>
<td>Once both parties have signed the Project Agreement, senior technical staff of each organization will lead the work at PARC and at the Client.</td>
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