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***Abstract*—Street lights are a ubiquitous public infrastructure in urban areas that can be leveraged for smart city applications. In this paper, we present a demo of an electric vehicle (EV) charger that is integrated with a street light and uses Wi-SUN network and OneM2M middleware to communicate with other devices and services. We demonstrate how street lights can be used as charging stations for e-bikes that are for rent, making it easy for e-bike rental companies to make charging stations across cities. We also discuss the benefits and challenges of using street lights as a platform for smart city applications.**

***Index Terms*—street lights, smart city, EV charger, Wi-SUN, OneM2M**

I. Introduction

Street lights are a basic and important facility of cities, illuminating roads and sidewalks to increase the safety and security of road users and pedestrians. However, street lights can also serve as a versatile and extensible platform for smart city applications, as they are electrically operated, densely deployed, and publicly owned 1. By augmenting treet lights with sensors, actuators, computing, networking, and Internet-of-Things (IoT) components, they can enable a wide range of innovative services and applications for the urban environment, uch as traffic monitoring, environmental sensing, digital signage, WiFi access, or e-vehicle charging.

One of the promising applications of street lights is to use them as charging stations for electric vehicles (EVs), especially e-bikes that are becoming popular modes of transportation in cities. E-bikes are bicycles that have an electric motor that assists the rider's pedaling. They offer many benefits for urban mobility, such as reducing greenhouse gas emissions, improving health and fitness, saving time and money, and enhancing accessibility and convenience [3]. However, one of the main challenges for e-bike users is to find available and reliable charging stations in the city. This is especially true for e-bike rental companies that need to manage a large fleet of e-bikes and ensure their availability and performance for customers.

In this paper, we present a demo of an EV charger that is integrated with a street light and uses Wi-SUN network and OneM2M middleware to communicate with other devices and services. Wi-SUN is a wireless standard that provides machine-to-machine communication for large-scale IoT infrastructure. It uses IPv6-based mesh technology that allows end nodes to connect directly and dynamically to several nearby nodes to form the network[4]. OneM2M is a global standard that defines an architectural framework based on a middleware technology that lies in the horizontal layer between IoT applications and a lower layer of communication networks and connected devices. The middleware layer provides a rich set of common services for data management, security, discovery, and interoperability .

We demonstrate how street lights can be used as charging stations for e-bikes that are for rent, making it easy for e-bike rental companies to make charging stations across cities. We also discuss the benefits and challenges of using street lights as a platform for smart city applications. The main contributions of this paper are:

1) We design and implement a prototype of an EV charger that is integrated with a street light and uses Wi-SUN network and OneM2M middleware.
2) We show how the EV charger can interact with other devices and services, such as e-bikes, smartphones, cloud servers, and payment systems, to provide a seamless and convenient charging experience for users.
3) We evaluate the performance and usability of the EV charger and compare it with existing solutions.
4) We identify the opportunities and challenges of using street lights as a platform for smart city applications, such as scalability, security, privacy, and governance.

The rest of this paper is organized as follows. Section 2 reviews the related work on street lights as a platform for smart city applications and EV charging. Section 3 describes the design and implementation of the EV charger prototype. Section 4 presents the demo scenario and the evaluation results. Section 5 discusses the benefits and challenges of using street lights as a platform for smart city applications. Section 6 concludes the paper and outlines future work.

II. Ease of Use

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Define abbreviations and acronyms the first time they are used in the text, even after they have been defined in the abstract. Abbreviations such as IEEE, SI, MKS, CGS, ac, dc, and rms do not have to be defined. Do not use abbreviations in the title or heads unless they are unavoidable.

B. Units

- Use either SI (MKS) or CGS as primary units. (SI units are encouraged.) English units may be used as secondary units (in parentheses). An exception would be the use of English units as identifiers in trade, such as "3.5-inch disk drive".
- Avoid combining SI and CGS units, such as current in amperes and magnetic field in oersteds. This often leads to confusion because equations do not balance dimensionally. If you must use mixed units, clearly state the units for each quantity that you use in an equation.
- Do not mix complete spellings and abbreviations of units: "Wb/m^2" or "webers per square meter", not "webers/m^2". Spell out units when they appear in text: ". . . a few henries", not ". . . a few H".
- Use a zero before decimal points: "0.25", not ".25". Use "cm^3", not "cc".)

C. Equations

Number equations consecutively. To make your equations more compact, you may use the solidus (/), the exp function, or appropriate exponents. Italicize Roman symbols for quantities and variables, but not Greek symbols. Use a long dash rather than a hyphen for a minus sign. Punctuate equations with commas or periods when they are part of a sentence, as in:

$$a + b = \gamma \tag{1}$$

Be sure that the symbols in your equation have been defined before or immediately following the equation. Use "(**??**)", not "Eq. (**??**)" or "equation (**??**)", except at the beginning of a sentence: "Equation (**??**) is . . ."

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Please use "soft" (e.g., `\eqref{Eq}`) cross references instead of "hard" references (e.g., `(1)`). That will make it possible to combine sections, add equations, or change the order of figures or citations without having to go through the file line by line.

Please don't use the `{eqnarray}` equation environment. Use `{align}` or `{IEEEeqnarray}` instead. The `{eqnarray}` environment leaves unsightly spaces around relation symbols.

Please note that the `{subequations}` environment in LaTeX will increment the main equation counter even when there are no equation numbers displayed. If you forget that, you might write an article in which the equation numbers skip from (17) to (20), causing the copy editors to wonder if you've discovered a new method of counting.

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Do not use `\nonumber` inside the `{array}` environment. It will not stop equation numbers inside `{array}` (there won't be any anyway) and it might stop a wanted equation number in the surrounding equation.

E. Some Common Mistakes

- The word "data" is plural, not singular.
- The subscript for the permeability of vacuum μ_0, and other common scientific constants, is zero with subscript formatting, not a lowercase letter "o".
- In American English, commas, semicolons, periods, question and exclamation marks are located within quotation marks only when a complete thought or name is cited, such as a title or full quotation. When quotation marks are used, instead of a bold or italic typeface, to highlight a word or phrase, punctuation should appear outside of the quotation marks. A parenthetical phrase or statement at the end of a sentence is punctuated outside of the closing parenthesis (like this). (A parenthetical sentence is punctuated within the parentheses.)
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- In your paper title, if the words "that uses" can accurately replace the word "using", capitalize the "u"; if not, keep using lower-cased.

- Be aware of the different meanings of the homophones "affect" and "effect", "complement" and "compliment", "discreet" and "discrete", "principal" and "principle".
- Do not confuse "imply" and "infer".
- The prefix "non" is not a word; it should be joined to the word it modifies, usually without a hyphen.
- There is no period after the "et" in the Latin abbreviation "et al.".
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Component heads identify the different components of your paper and are not topically subordinate to each other. Examples include Acknowledgments and References and, for these, the correct style to use is "Heading 5". Use "figure caption" for your Figure captions, and "table head" for your table title. Run-in heads, such as "Abstract", will require you to apply a style (in this case, italic) in addition to the style provided by the drop down menu to differentiate the head from the text.

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a) Positioning Figures and Tables: Place figures and tables at the top and bottom of columns. Avoid placing them in the middle of columns. Large figures and tables may span across both columns. Figure captions should be below the figures; table heads should appear above the tables. Insert figures and tables after they are cited in the text. Use the abbreviation "Fig. **??**", even at the beginning of a sentence.

Fig. 1. Example of a figure caption.

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TABLE I
TABLE TYPE STYLES

Table Head	**Table Column Head**		
	Table column subhead	***Subhead***	***Subhead***
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[a]Sample of a Table footnote.

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REFERENCES

[1] https://github.com/SiliconLabs/wisun-br-linux
[2] https://www.silabs.com/documents/public/quick-start-guides/qsg181-wi-sun-sdk-quick-start-guide.pdf
[3] https://www.silabs.com/documents/public/user-guides/ug495-wi-sun-developers-guide.pdf
[4] https://docs.silabs.com/simplicity-studio-5-users-guide/1.0/about-the-simplicity-ide/overview/project-explorer-view
[5] R. Nicole, "Title of paper with only first word capitalized," J. Name Stand. Abbrev., in press.
[6] Y. Yorozu, M. Hirano, K. Oka, and Y. Tagawa, "Electron spectroscopy studies on magneto-optical media and plastic substrate interface," IEEE Transl. J. Magn. Japan, vol. 2, pp. 740–741, August 1987 [Digests 9th Annual Conf. Magnetics Japan, p. 301, 1982].

[7] M. Young, The Technical Writer's Handbook. Mill Valley, CA: University Science, 1989.

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