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Witnesses: Bradley Baugh

PREPARED DIRECT TESTIMONY OF

BRADLEY M. BAUGH

ON BEHALF OF SAN DIEGO GAS & ELECTRIC COMPANY

CHAPTER 5

(SMART METER 2.0 INFORMATION TECHNOLOGY AND NETWORK REQUIREMENTS)

BEFORE THE PUBLIC UTILITIES COMMISSION

OF THE STATE OF CALIFORNIA

December 18, 2025

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PREPARED DIRECT TESTIMONY OF
BRADLEY M. BAUGH
CHAPTER 5
(SMART METER 2.0 INFORMATION TECHNOLOGY AND NETWORK REQUIREMENTS)

I. INTRODUCTION

This chapter describes San Diego Gas & Electric Company's (SDG&E) proposed Advanced Metering Infrastructure (AMI) Program, which includes Smart Meter (SM) 2.0 Foundational and NextGen Technology, as well as legacy SM 1.0 Technology. This includes both the implementation of information technology (IT) systems and the network needed to support the SM 2.0 Gas Module Replacements, Electric Meter Replacements, and NextGen capabilities. This also includes the IT and network activities to support SM 1.0 technology which includes legacy system updates and network mitigation measures during the transition to SM 2.0.

Specifically, this testimony covers the IT solution and network required to: 1) receive the smart meter data from devices installed as part of gas module and electric meter replacement to the new Head-End System (HES), 2) transfer the data from the HES to the Meter Data Management System (MDMS) and SDG&E's Customer Information System (CIS) to validate, edit, and store the data for customer billing, 3) distribute data to relevant downstream systems and analytics platforms, and 4) continue to update our current smart meter systems[1] and implement network mitigation measures.

This prepared direct testimony is organized in the following sections:

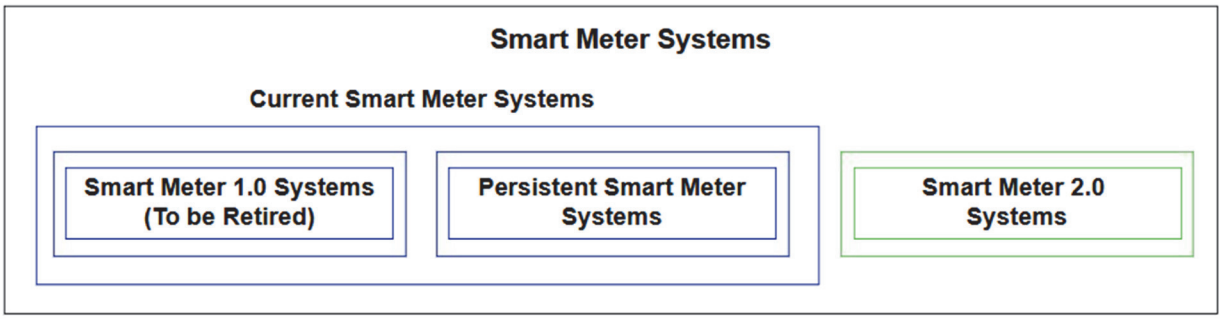
- Section I provides an introduction, summarizing SDG&E's request.

[1] The "Current Smart Meter Systems" are the set of systems comprised of both SM 1.0 Systems and Persistent SM Systems defined in Section II.B.1 of this prepared direct testimony.

- Section II provides an overview of SDG&E's SM 1.0 legacy technology and describes the plans for updates and mitigations overlapping the transition to SM 2.0.
- Section III discusses the future state smart meter architecture, new systems, integrations, system remediations, and network needed to enable SM 2.0.
- Section IV provides a conclusion, summarizing this testimony

This testimony addresses various groups of IT systems related to the AMI Program scope of work— defined collectively as 'smart meter systems'—that will be retired, updated, or newly implemented in support of the AMI Program. These systems are categorized and described below and referenced in Figure 5-1.

Figure 5-1
Smart Meter Systems[2]



1) ***Current Smart Meter Systems:*** This term refers to the smart meter systems that are utilized by SDG&E today. They are comprised of the combination of SM 1.0 systems (to be retired) and persistent smart meter systems, as defined below.

2) ***SM 1.0 Systems (to be retired):*** These systems refer to the SM 1.0 HES, the associated Hardware Security Module (HSM) , the radio frequency local area

[2] This illustration is also presented as Figure 3-1 in Chapter 3.

network (RFLAN), (range extenders, socket-based routers, etc.) and the Zigbee gas module network that will be retired as part of SM 2.0 after all SM 1.0 electric meters and gas modules are replaced with SM 2.0 technology. The SM data mart (data warehouse) is also considered a SM 1.0 system as it is being retired after being replaced by the SM cloud data lake.

3) ***Persistent SM Systems (ongoing):*** This term refers to the portion of the current ***smart*** meter systems that are not being replaced and will remain after the AMI program, and will be continually maintained, updated, and enhanced. These systems include:[3]

- Meter Data Management System (MDMS)
- MV-90
- Energy Data Access (EDA)
- Meter Shop Activity Portal (MSAP)
- SDG&E/Southern California Gas Company (SoCalGas) Core Balancing
- Smart Meter Cloud Data Lake
- Centralized Operational Key Performance Indicators (KPIs) and Exceptions (COKE)
- Customer Energy Network (CEN)

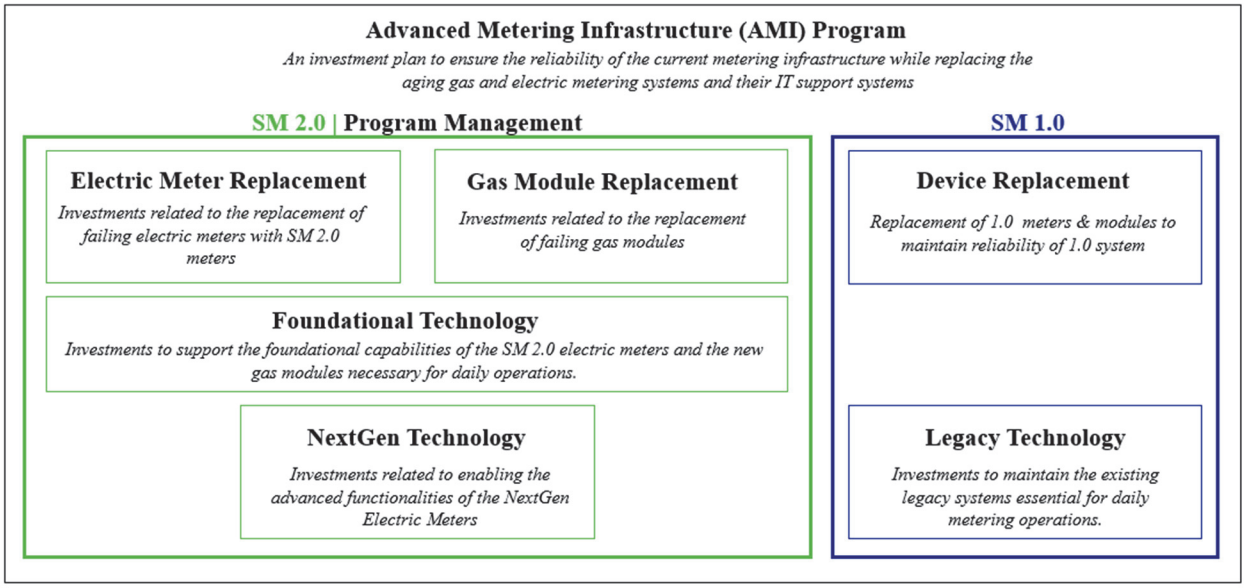
4) ***SM 2.0 Systems:*** These systems refer to the new smart meter systems that will be deployed to implement the foundational and NextGen capabilities, which includes the new HES, installation and troubleshooting field tools, grid edge applications

[3] For further descriptions of Persistent SM Systems, please reference Section II.A.3, *Backoffice IT System Components of the Legacy Architecture* in this testimony.

(applications installed within the meter itself) and a vendor Software-as-a-Service (SaaS) analytics platform as described in the Future State Architecture section of this testimony.

This testimony also refers to various groupings of technology components that will make up the overall AMI IT and network technology. For the purposes of this testimony, the following diagram defines the AMI program components that will be supported by SM 2.0 Foundational, NextGen, and SM 1.0 Legacy Technology. These groupings are described in Figure 5-2 and discussed below.

Figure 5-2
AMI Program Structure[4]



1) ***SM 2.0: Foundational Technology:*** This refers to the technology solution that will be implemented to ***support*** the electric meter and gas module replacements, and includes foundational SM 2.0 capabilities, such as billing operations

[4] This illustration is also presented as Figure 3-2 in Chapter 3.

functionality. This technology solution is relevant to persistent smart meter systems and SM 2.0 systems.

2) ***SM 2.0: NextGen Technology:*** This refers to the technology solution that will be implemented to support NextGen capabilities, including those grid edge applications described in Chapter 3 such as customer insights: real-time energy ***monitoring***, transformer health & load management, meter transformer mapping, and phase identification. This technology solution is relevant to persistent smart meter systems and SM 2.0 systems.

3) ***SM 1.0: Legacy Technology****:* This refers to investments to sustain the reliability of the SM 1.0 metering infrastructure during the transition to SM 2.0, which includes SM 1.0 system updates and network mitigation measures. These technology changes are relevant to SDG&E's current smart meter systems.

The remainder of this prepared direct testimony addresses the various systems, functions and work required to enable the SM 2.0 Technology. This includes:

- Development of a cloud-based SM 2.0 HES
- Implementing a new SM 2.0 Long-Term Evolution (LTE) meter-to-cloud communications network for electric meters and gas modules
- Integration of SM 2.0 processes and data into SDG&E's existing IT systems
- Remediation of current systems to ensure compatibility with SM 2.0 systems
- Integrations with a mass deployment vendor's systems
- SM 2.0 grid edge applications with the associated vendor SaaS analytics platform

A. SDG&E IT Strategy and Alignment with the AMI Program

SDG&E's IT strategy focuses on transforming operations to deliver technology solutions that meet business needs and customer expectations through innovation, modern practices, and advanced technologies. The AMI program strongly aligns with several key pillars of this IT strategy, as outlined below.

- **Simplify and Standardize:** SDG&E's proposed plan will streamline infrastructure and applications to enhance system efficiency and performance. SDG&E has determined that when business requirements can be satisfied by existing market software, purchasing software rather than developing it in-house often allows for quicker implementation, reduces technical debt, and enables adaptation to changes, while allowing the company to focus on core business activities.[5] SDG&E has determined that cloud models (including both Software-as-a-Service) are often more effective and cost efficient and therefore seeks new cloud offerings from SM 2.0 vendors for foundational and NextGen capabilities.
- **Proactively Manage Risk**: This pillar emphasizes disciplined management of the technology lifecycle and cyber risks associated with infrastructure and applications. The AMI program will replace outdated systems, including the current HES and network, enhancing cybersecurity and reducing technical debt linked to aging technologies.
- **Accelerate Digital**: To prepare for the future, SDG&E plans to modernize technologies and drive rapid innovation that supports business insights and

[5] Technical debt is the accrued cost and risks associated with outdated system security, processes, software, and hardware.

decisions. The AMI program will incorporate advanced analytics through grid edge applications and a vendor SaaS analytics platform, enabling the use of Artificial Intelligence (AI) and Machine Learning (ML) for NextGen capabilities.

II. CURRENT STATE OF SM 1.0 LEGACY TECHNOLOGY

A. Background of Existing SM 1.0 Infrastructure

This section provides background on SDG&E's existing SM 1.0 infrastructure and explains why continued investment in these legacy systems is necessary during the SM 2.0 rollout and beyond to maintain reliability and customer service.

In the following sections, SDG&E will:

- Outline the components of SM 1.0 legacy technology.
- Explain why updates are required during the transition to SM 2.0.
- Describe why network mitigation measures for SM 1.0 remain necessary during this period.

Although SDG&E is not requesting cost recovery for legacy system updates or network mitigation measures in this application,[6] this section is included to provide context on these activities and how they relate to SDG&E's SM 2.0 request.

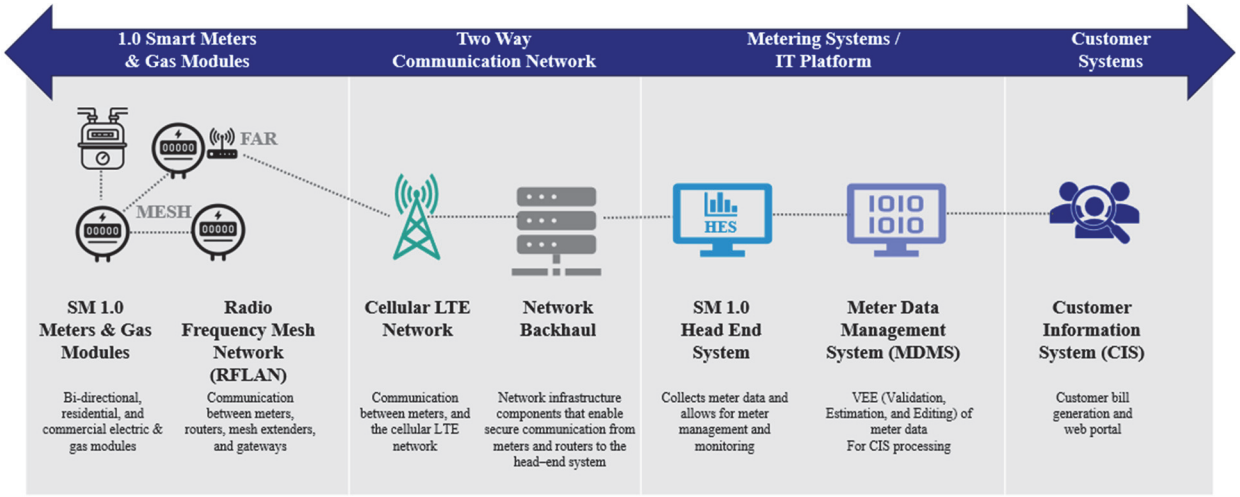
1. Current State Legacy Billing Operations– SM 1.0 Legacy Technology Overview and Architecture

Figure 5-3 below provides a high-level overview of the end-to-end billing operations legacy technology deployed as part of the SM 1.0 program. SDG&E's SM 1.0 infrastructure uses RFLAN where electric meters and gas modules transmit data to Field Area Routers (FARs).

[6] SM 1.0 costs are being tracked in a Smart Meter 2.0 Memorandum Account (SM2MA) per SDG&E Advice Letter 4605-E/3401-G, Establishment of a Smart Meter 2.0 Memorandum Account Pursuant to General Rate Case Decision 24-12-074, approved May 6, 2025 and effective May 2, 2025.

These FARs act as gateways, securely sending meter data to SDG&E's HES via cellular LTE connections. The HES enables two-way communication between smart meters, gas modules, and SDG&E's back-office systems.

Figure 5-3
SM 1.0 End-To-End Infrastructure[7]

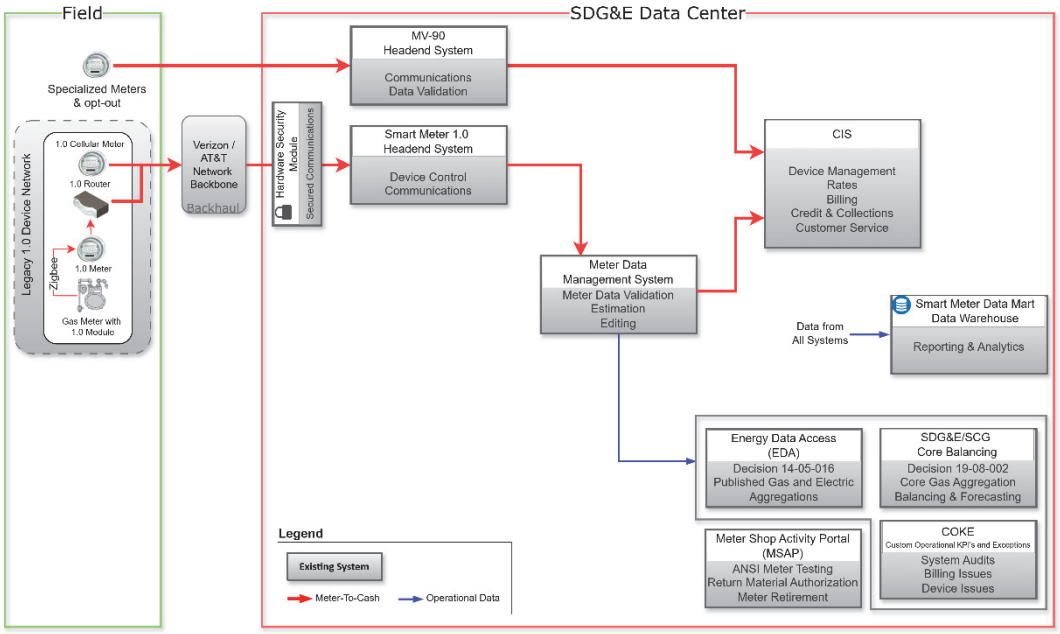


The subsequent architecture figures describe the specific systems and technologies utilized in the current smart meter solution, highlighting how these systems integrate with other utility back-office systems.

Figure 5-4 below is a high-level representation of SDG&E's current billing operations process, with references to the specific systems in place. This core business process illustrates how meter data flows through essential systems to generate customer billings. Figure 5-4 also depicts the systems that use smart meter data for operational purposes.

[7] This illustration is also presented as Figure 2-1 in Chapter 2 and Figure 3-4 in Chapter 3.

Figure 5-4
Current Smart Meter Systems – Legacy Billing Operations Architecture



2. Field Communications Components of Legacy Architecture

The Field section in Figure 5-4 above is a depiction of the physical field communications components of the SM 1.0 system. Below is a summary of these components in more detail:

- **Electric Meters –** The mesh network consists of electric meters, which communicate peer-to-peer across distances of up to 500 feet. There are also approximately 1,000 cellular electric meters that do not use the mesh network (due to inability of meter to communicate with other meters due to distance or barriers, or unique requirements of the meter) and are directly connected to the cellular network.
- **Gas Modules –** At the network's edge are the SM 1.0 gas modules. Having no connected power, **they** are battery operated and communicate to a single, bound electric meter using the low-power, low-data-rate Zigbee protocol to conserve battery life. These gas modules can only be read with the current legacy HES.

- **Current SM 1.0 FAR and RFLAN Mesh –** Most of the SM 1.0 electric meters communicate via a proprietary RFLAN mesh network to a FAR, and then through FARs to the HES. In this mesh architecture, meters relay data through neighboring devices in a multi-hop network, allowing meter data to reach the nearest FAR. The FARs collect all electric meter and gas module data and transmit the data back to SDG&E's back-office system via a cellular LTE link on a commercial cellular carrier, either AT&T or Verizon.

3. Back Office IT System Components of the Legacy Architecture

The left side of the SDG&E Data Center section in Figure 5-4 above begins with the HES, which collects data from electric meters and gas modules. This data is then sent to the MDMS, where it is aggregated, validated, and processed. Finally, the validated meter data is forwarded to the CIS for billing and other back-office operations. Operational systems that use smart meter data are also included. These components work together to ensure efficient data flow for billing and operational use cases within SDG&E. The following explains the functionality of each system in more detail:

- **HES:** Serves as the central platform for secure, two-way communication between electric meters, gas modules, and back-office systems, enabling data exchange and remote control, such as remote connect and disconnect. It is important to note that the current HES is only capable of reading the SM 1.0 electric meters and cellular meters designed to work with this HES.
- **MDMS:** A centralized platform for data processes commonly referred to as data Validation, Estimation, and Editing (VEE). The MDMS is also used for data

aggregation and analysis, volume data processing and storage of data from electric meters and gas modules.

- **MV-90:** A legacy meter reading solution for opt-out and large commercial and industrial non-smart meters. SDG&E's MV-90 system currently reads about 1,000 industrial grade non-smart meters, which includes primary and interconnect meters.[8] There is also a process to load manually read opt-out meter data into MV-90. This data is then sent to SDG&E's CIS.
- **Customer Information System (CIS):** The CIS manages customer data, billing, and credit and collections. The CIS service order and device management functions are used for electric meter and gas meter/module service orders.
- **Energy Data Access (EDA) & Core Gas Customer Balancing:** SDG&E systems that support regulatory data aggregation and reporting. The EDA system compiles electric and gas usage data on a quarterly basis to meet compliance requirements.[9] The core gas customer balancing system transmits daily residential and small commercial core customer gas usage data to SoCalGas to support forecasting and system balancing.[10]
- **Meter Shop Activity Portal (MSAP):** An SDG&E application used by the Meter Shop department to test electric meters against American National Standards

[8] An electric high-voltage interconnect meter is a metering device installed at points where two electrical systems—typically between utilities, substations, or large industrial customers—interconnect at medium to high voltages (typically above 1 kV, often 13.8 kV to 230 kV or higher).

[9] EDA is implemented to support California Public Utilities Commission (Commission or CPUC) Decision 14-05-016 which requires that utilities proactively post quarterly aggregate commodity usage data. SDG&E's aggregation data is publicly available at https://energydata.sdge.com/.

[10] Natural Gas forecasting and balancing requirements per R.20-01-007 under Rule 30.

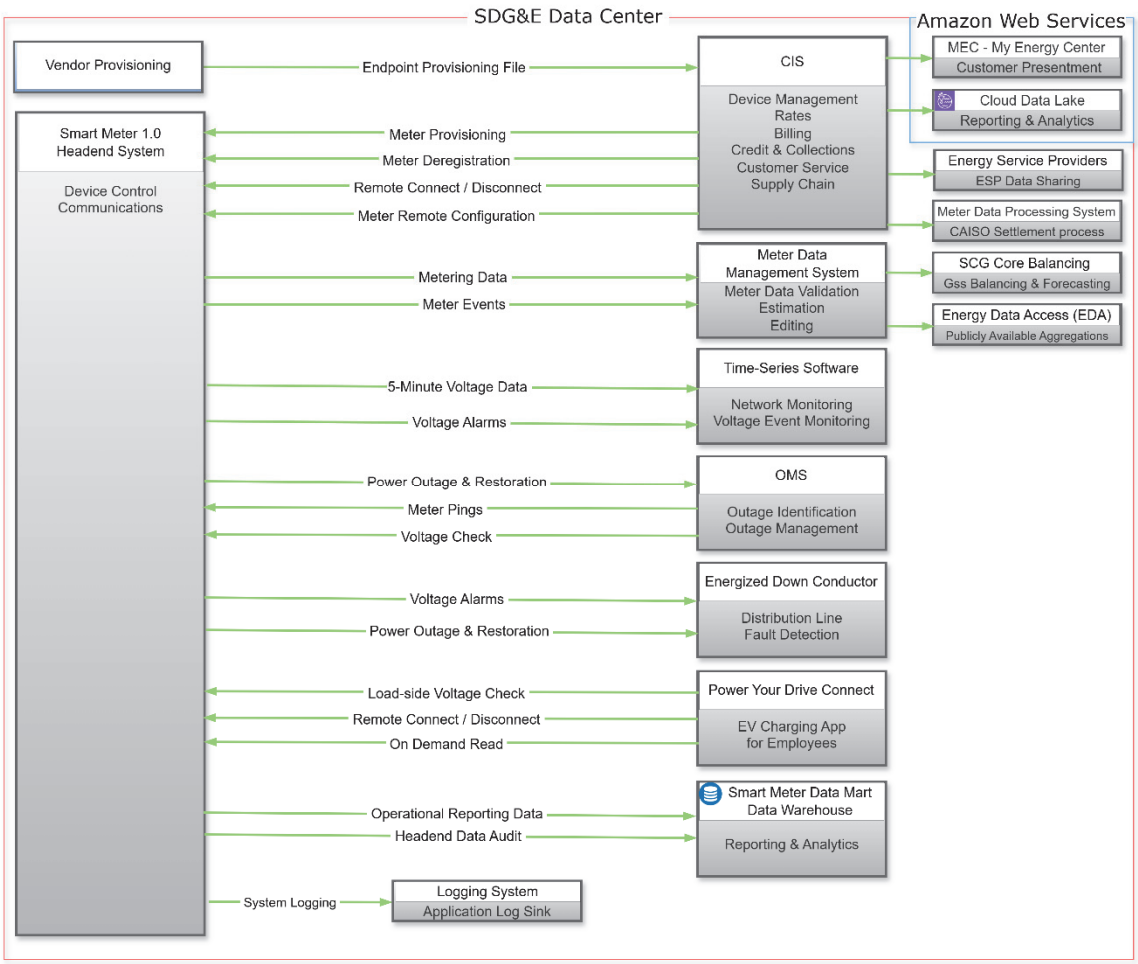
Institute (ANSI) standards. It allows technicians to access meter information and transfers testing results to the CIS for record-keeping.

- **Centralized Operational KPIs & Estimation (COKE):** COKE is an issue management system that identifies and highlights meter, communication, and data-related problems, facilitating collaboration to resolve problems with incomplete billing data from the meter, and identifies meter performance issues.
- **Customer Energy Network (CEN):** CEN is SDG&E's implementation of the Green Button Connect My Data initiative designed for data sharing. It allows customers to grant third parties access to their energy data, enabling various third-party services.
- **Analytics System/Smart Meter Data Mart**: Data mart is an SDG&E data warehouse that is maintained for operational reporting and analytics.

4. Current SM 1.0 Systems Legacy Integrations and other Downstream Systems

In addition to the current smart meter systems, various integrations with other utility systems utilize data from current smart meter systems, primarily originating from the HES as illustrated in Figure 5-5 below.

Figure 5-5
Current State Smart Meter Systems Data Integrations



Key integrations include:

- **CIS:** In addition to the billing operations integrations, CIS has integrations to the HES that initiate meter configuration and remote control, including meter provisioning, remote connect/disconnect, ping, and remote meter configuration functions.
- **MDMS:** In addition to the metering data, the MDMS also receives events from the device population. The EDA and SoCalGas core balancing integrations aggregate metering data from the MDMS to fulfill certain requirements.

- **Outage Management System (OMS):** The OMS receives critical meter notification alerts related to power loss and restoration, as well as the ability to confirm restorations through use of selective meter pings.
- **Power Your Drive Connect (PYD-C):** Integration with SDG&E's on-campus electric vehicle (EV) charging application.
- **Transmission and Distribution Applications:** Integrations with the SDG&E time-series software for grid voltage data analysis and Energized Down Conductor (EDC) analysis system for identifying potentially downed electric conductors.
- **Smart Meter Data Mart:** This reporting data warehouse receives data from the HES to audit the data daily, looking for installations that don't match the data in CIS and other systems. It also provides reporting on performance versus service level agreements (SLAs) and KPIs.
- **Logging System:** Integrations into the logging system send detailed application logs for the purpose of security and runtime auditing, monitoring and error checking.

These SM 1.0 legacy integrations will ultimately be replaced by SM 2.0 integrations but will be maintained until all SM 1.0 electric meters and gas modules are replaced.

5. Current State of Legacy Network Solution

The legacy smart meter network at SDG&E uses a proprietary mesh communications network. All data from SM 1.0 electric meters and gas modules connected to the mesh are transmitted through FARs which are connected to SDG&E's back-office systems via a commercial cellular LTE link. The gas modules communicate through a low power Zigbee link,

which is designed for short range communication. The gas modules communicate directly to the electric meters and the electric meters pass on the gas module communications through the mesh. In this mesh network, each electric meter functions as a node, transmitting its usage data and relaying information from nearby electric meters and gas modules until it reaches a FAR. These FARs are 4G LTE routers that provide backhaul[11] to SDG&E's data systems through the national carriers of Verizon and AT&T. In some cases, legacy SM 1.0 meters, have embedded 4G LTE modules that allow them to bypass the mesh and communicate directly with the cellular network.

Approximately 63% of SDG&E's electric distribution system is underground, which limits the use of pole-top routers. This severely restricts options to place routers on power distribution poles. To address this, SDG& implemented behind-the-glass and socket-based router solutions. While these installations were innovative at the time, their low mounting position restricts line-of-sight and range. To improve coverage in hard-to-reach areas, SDG&E has deployed mesh range extenders, specialized external antennas, and socket-based routers, particularly in regions without overhead poles to extend service where cellular service is lacking.

6. Current State of Legacy Cybersecurity

Current cybersecurity efforts are primarily focused on securing communications between electric meters, gas modules, and SDG&E's HES, while also ensuring vendor software is regularly updated to address emerging vulnerabilities. The network security relies on proprietary protocols, perimeter-based defenses, and encrypted data transmission over utility-managed networks. Security measures include authentication, encryption, and physical tamper detection

[11] Network backhaul refers to the communication layer that transports data from smart meters and field devices to the utility's core systems, such as the HES. It acts as the backbone for metering and operational data, moving information from the grid's edge to centralized platforms for processing, analysis, and decision-making. Backhaul typically relies on technologies like fiber optics, cellular networks (*e.g.*, LTE), or radio signals to transmit data securely and efficiently over long distances.

in electric meters. SDG&E currently uses a HSM, hosted in the SDG&E data center, to secure communications between electric meters, gas modules, and the HES.

B. SM 1.0: Legacy Technology

This section describes the activities needed for both legacy system updates and network mitigation measures, which will be discussed in more detail below.

1. Legacy System Updates

This section describes the required activities for current smart meter 1.0 systems as part of legacy system updates.

The legacy system updates are necessary to ensure security, maintain vendor support, support business functions such as billing, and enable analytics for emerging operational needs. They pertain to all the current SM 1.0 systems, including the SM 1.0 systems that are to be retired. Although SDG&E has taken steps to minimize the cost of updating current smart meter systems before and during the SM 2.0 deployment, the SM 1.0 systems will remain critical and will require regular updates throughout the transition period until all electric meters and gas modules connected to the SM1.0 HES are replaced and the full deployment of SM 2.0 is complete. Planned updates to the SM 1.0 systems are limited to those required for critical business needs as necessary and prudent to ensure continued system viability and security until the systems are retired. The legacy system updates encompass all system updates completed and planned between 2024 and 2031. The activities involved in the updates are supported by product teams and include such activities as the regular cycle of applying and testing version updates to core systems such as the SM 1.0 HES, the MDMS, and MV-90. These essential updates follow a regular cadence, as prescribed by the vendor or SDG&E, to ensure safe, reliable, and secure service to our business and customers.

2. Network Mitigation Measures

This section explains the activities for the network mitigation measures covering 2024-2031. Network mitigation measures cover activities to address issues with the existing mesh network through the deployment of field hardware before and during the SM 2.0 electric meter and gas module replacement activities.

There will be SM 1.0 electric meters and gas modules that experience ongoing communication issues due to electric meter failures, physical location, environmental interference, or signal obstructions. When possible, a SM 2.0 meter solution will be used to address these issues, however, there will be circumstances where mitigating issues with the existing network is the most prudent course of action, such as in the case where there are impacts to the SM 1.0 mesh potentially affecting many customers. For the SM 1.0 network, SDG&E has employed multiple mitigation tools to connect meters that have radio frequency (RF) barriers.

III. FUTURE STATE SMART METER ARCHITECTURE – FOUNDATIONAL AND NEXTGEN TECHNOLOGY

A. Summary Of Foundational and NextGen Technology

SDG&E has developed a plan for a Technology Solution that meets the objectives and capabilities of a modernized SM 2.0 system. The proposed foundational and NextGen technology includes the following core components:

- An integrated two-way communications network (defined as meter-to-cloud connectivity) of SM 2.0 electric meters and gas modules capable of transmitting smart meter data at defined intervals as well as remote control (such as remote connect/disconnect). The network will utilize an LTE communications network through commercial cellular carriers (*e.g.*, Verizon, AT&T, and T-Mobile). For those electric meters that do not have sufficient LTE coverage, and LTE coverage

cannot be extended to cover them, a micro-mesh[12] router will be added to create a mesh link to the electric meters and gas modules.

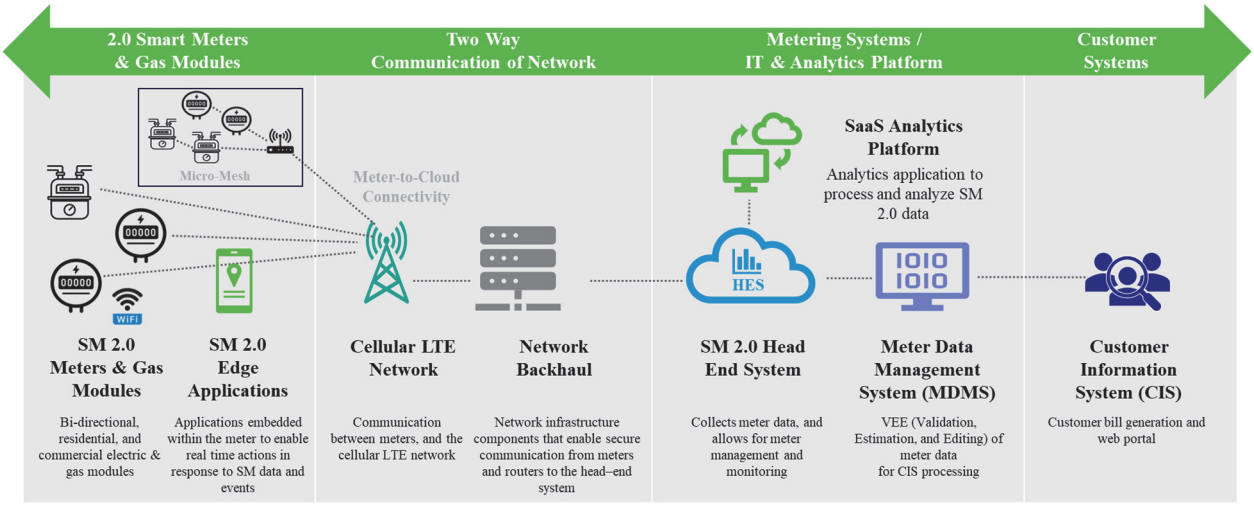
- Embedded Wi-Fi capability in SM 2.0 electric residential meters provides local, high-bandwidth connectivity at the customer premises. This interface supports customer-facing applications such as customer insights: real-time energy monitoring, as well as potential integration with customer Distributed Energy Resource (DER) systems and Electric Vehicles (EV). Wi-Fi serves as an additional communication path to the primary SM 2.0 network, dedicated to specific customer enabling functionality.
- Metering systems such as a new SM 2.0 HES with integrations to and from downstream systems such as MDMS and CIS, along with SM 2.0 vendor specific field tools for installation processes and troubleshooting. Field tools will be used to install, troubleshoot, and gather information from meter/module devices in the field.
- Vendor provisioned grid edge applications and a SaaS analytics platform to enable desired SDG&E NextGen capabilities.
- Cybersecurity protections to collect, validate, analyze, store and manage meter data securely and efficiently.

Figure 5-6 below provides a high-level overview of the end-to-end view of foundational and NextGen technology that will be deployed as part of SM 2.0. The subsequent diagrams

[12] Micro-Mesh is a localized mesh network to relay data from smart meters to the HES, ensuring reliable communication in hard-to-reach locations.

describe this solution with references to the systems and technologies that will be used in the future state.

Figure 5-6
SM 2.0 End-To-End Infrastructure[13]



B. Interim Solution – Coexistence of both Current Smart Meter Systems and SM 2.0 Systems

During the SM 2.0 deployment, both SM 1.0 and SM 2.0 gas modules and electric meters will be active in SDG&E's service territory, defined as the "interim state" when both current SM 1.0 systems and SM 2.0 systems will coexist. As a result, both SM 1.0 HES and SM 2.0 HES are required to retrieve meter data for billing and to support connected applications like the OMS.

1. Interim Architecture for Foundational and NextGen Technology (Billing Operations Process)

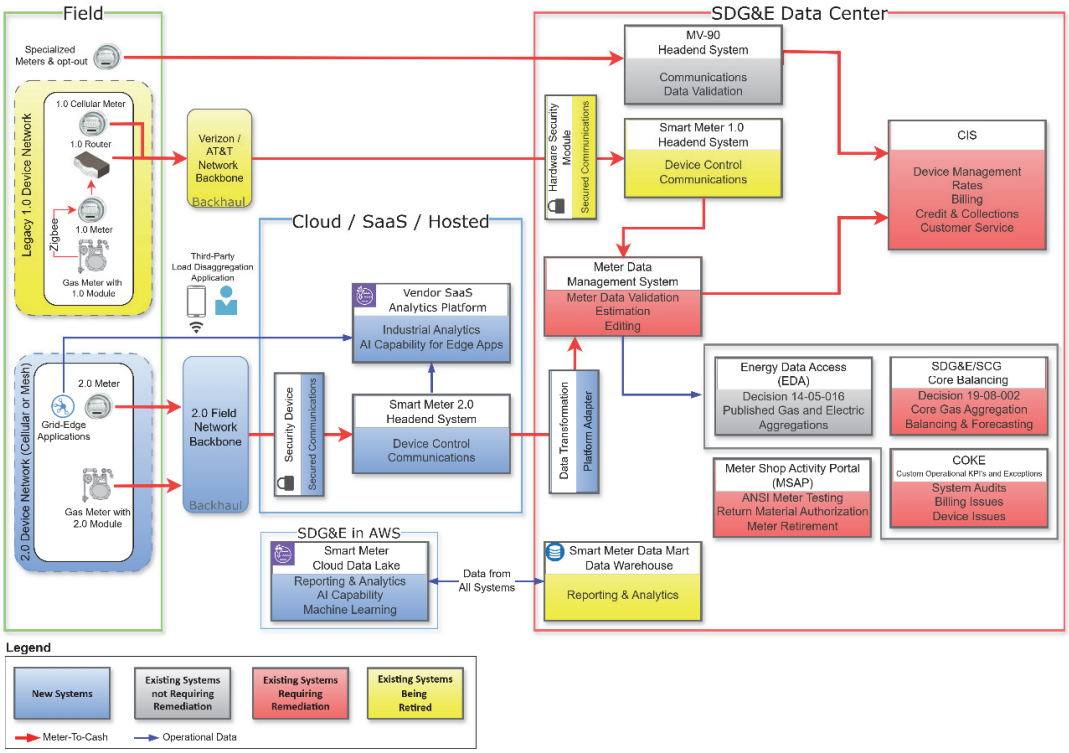
Figure 5-7 illustrates the interim solution in which both the current SM 1.0 systems and future SM 2.0 systems operate concurrently to maintain billing operations functionality. During this interim period, several SM 2.0 systems will be introduced. These new SM 2.0 system components will continue to exist beyond the end of the AMI Program. These include:

[13] This illustration is also presented as Figure 3-3 in Chapter 3.

- A new HES
- A new meter-to-cloud communications network
- A SM cloud data lake for custom analytics utilizing AI
- A vendor SaaS analytics platform for NextGen capabilities
- Grid-edge applications that run on the electric meters for NextGen capabilities

The existing MDMS will receive data from both the SM 1.0 HES and the SM 2.0 HES until full deployment is complete, as shown in Figure 5-7.

Figure 5-7
Interim View of Foundational and NextGen Technology before the SM 1.0 Systems are Retired



2. Interim Period – Introduction of New HES

During this interim period, the new SM 2.0 HES will be implemented to support new SM 2.0 electric meters and gas modules. SDG&E understands that the SM 2.0 HES must be flexible enough to meet the future state needs of the customer, the industry, and regulatory environment.

The new HES will be implemented through a SaaS/cloud hosting model, with the selected SM 2.0 vendor managing the software and infrastructure via cloud providers. This model assigns the vendor responsibility for system maintenance and updates, and a robust disaster recovery and failover design. The system will be scalable, highly secure, modular, and standards-based, utilizing a versatile network architecture capable of collecting data from the field through various communication technologies, including cellular electric meters and gas modules, and a micro-mesh when needed. Scalability will be achieved through horizontal scaling, allowing for the automatic addition of servers in the cloud as needed, facilitating on-demand and event-driven data collection and processing for new electric meters and gas modules, as well as regular periodic data collection.

Additionally, the new HES will support integrations with other SDG&E systems and provide scalable interfaces for advanced analytics. Data extraction will be facilitated through a catalog of interfaces that adhere to common utility integration standards, such as MultiSpeak and the Common Information Model (CIM). This will enable standardized data transfer with all SDG&E downstream systems, including meter data transfer, on-demand transactions, gas module and electric meter provisioning, and event forwarding (*i.e*. power-off notifications being sent to the OMS system in real-time). The interfaces will accommodate both direct system-to-system integration and integration via SDG&E's middleware solution.

3. Interim Period – Introduction of Enhanced Cybersecurity

During the interim period, SDG&E will implement advanced security measures to safeguard the new foundational and NextGen technology introduced under SM 2.0. These measures are designed to meet enhanced cybersecurity requirements and support grid edge applications.

Customer data will be hosted within a dedicated tenant architecture in a third-party cloud. Integrations will utilize secure application programming interfaces (APIs) and adhere to industry standards, including CIM, MultiSpeak, and file-based protocols.

The HES and associated field tools will require unique user accounts for authentication. Role-based access will be managed through Identity and Access Management (IAM) and supported by Security Assertion Markup Language (SAML), Single Sign-On (SSO), and Multi-Factor Authentication (MFA). The solution will facilitate secure access to various functionalities, including event messaging and endpoint configuration.

In transit data encryption will be implemented at the networking layer using National Institute of Standards and Technology (NIST) approved encryption protocols, along with uniquely keyed application layer messaging encryption for privacy between endpoints and the HES. Data stored in systems will be protected through encryption at rest with strong encryption key management practices.

SDG&E will engage a third party for penetration testing of network and software layers, and electric meters and gas modules.

Grid edge applications will implement security for grid edge enabled devices running self-contained applications, utilizing Public Key Infrastructure (PKI) for managing digital keys and certificates, ensuring secure information exchange. Grid edge applications that run on the meter will also be tested and certified for security by the SM 2.0 vendor before being published.

In addition, the SM 2.0 solution will incorporate the following device-specific protections:

- **Device-specific encryption keys -** Each device will be provisioned with a unique encryption/decryption key to protect the confidentiality and integrity of data and

commands sent to the device. SDG&E will have the ability to replace keys as needed to manage the key lifecycle.

- **Time-bound field tool authentication -** Field tool access will be secured through time-limited authentication certificates, preventing unauthorized use after session expiration.
- **Downstream message authentication -** Endpoints will verify messages using a digital signature to ensure commands originated from a trusted source and adding proof of-origin and receipt to each downstream message to prevent unauthorized commands, such as service disconnects, from impacting operations.
- **Hardware-based root-of-trust security -** Cryptographic keys will be secured by design and protected against compromise.

These technical safeguards form the foundation of SDG&E's broader cybersecurity strategy, which applies a layered approach to protect the integrity of SM 2.0 systems and ensure compliance with regulatory standards.

The IT department employs a five-pillar model to support digitalization, with a focus on proactively managing risks associated with infrastructure and applications.

Key components of SDG&E's cybersecurity strategy include:

1. **Risk Management Framework**: Guided by SDG&E's Cybersecurity governance framework, the protection of sensitive customer information and the integrity of metering infrastructure is prioritized.
2. **Layered Defense Strategy**: This includes five areas:
    - **Perimeter Defenses**: Protecting external access points with firewalls and intrusion detection systems.

- **Internal Defenses**: Preventing unauthorized access within the network through enhanced access management.
- **Sensitive Data Protection**: Safeguarding customer information with identity access management, encryption, and data loss prevention technologies.
- **Operational Technology Cybersecurity**: Securing critical electric and gas control systems with monitoring and anomaly detection tools.
- **Obsolete IT Infrastructure Replacement**: Regularly updating IT systems to mitigate cybersecurity risks.

3. **Standards and Best Practices**: Adhering to standards and best practices set by agencies like the CPUC and the NIST to ensure robust security measures.
4. **Continuous Monitoring**: Utilizing advanced analytics and threat intelligence to identify and respond to emerging threats in real-time.

SDG&E has developed a robust cybersecurity framework to protect operations and ensure regulatory compliance while building customer trust in an increasingly digital grid. Overall, SDG&E's cybersecurity program is a comprehensive initiative aimed at protecting the integrity of its smart metering infrastructure while ensuring reliable energy delivery. It emphasizes risk management, compliance, technological innovation, and employee training to enhance security in a rapidly evolving digital landscape.

In addition to SDG&E's internal cybersecurity measures, the SM 2.0 IT and network solution will also rely on third-party vendor controls. To address risks introduced by these external partners, SDG&E incorporates Third-Party Risk Management (TPRM) processes. TPRM provides a structured approach to vetting vendors, embedding contractual safeguards, and

continuously monitoring performance and security compliance, ensuring that external providers meet the same rigorous standards for data protection and system integrity as SDG&E's internal operations.

Securing the SM 2.0 system is crucial as it will act as the digital gateway between SDG&E and millions of customer endpoints. Modern smart meters, which feature on-demand and event-driven data collection, and grid edge computing, have become attractive targets for cyberattacks. A successful breach could compromise customer privacy, disrupt billing accuracy, enable energy theft, or threaten grid stability. To mitigate these risks, SDG&E will implement multiple layers of security including authentication, encrypted communications, role-based access controls for employees and vendors, regular patching, logging, and security monitoring and real-time threat detection leveraging advanced analytics to identify abnormal device behavior and suspicious access patterns.

4. Interim Period - New Smart Meter Cloud Data Lake

SDG&E is in the process of adopting a corporate-wide cloud modernization initiative resulting in the enterprise cloud data lake. As SDG&E continues to build on that foundational platform, the SM data mart will be replaced with a SM cloud data lake as an extension to the enterprise cloud data lake. The migration of the SM cloud data lake brings many advantages over the present, isolated data mart approach, including enhanced data governance, security, data sharing, standardization, and scalability. SM 2.0 will incorporate new data from SM 2.0 systems into the SM cloud data lake to support reporting and analytics use cases. Such use cases include auditing the SM 2.0 HES against CIS for accuracy of installed meters; locating and addressing gaps in customer data; identifying misconfigured endpoints; remedying electric and gas metering issues to maintain bill quality; giving SDG&E's business and IT operations teams near real-time awareness of system performance; and ensuring that the selected SM 2.0 vendor meets

contractual service level agreements. In addition, the broader enterprise cloud data lake initiative will make SM 2.0's enhanced data features available across the organization, allowing it to be combined with data from multiple sources, and facilitating new NextGen use cases utilizing the power of cloud-based AI capabilities.

5. Interim Period - SM 2.0 Network Solution (Meter-to-Cloud Connectivity)

During this interim period, SDG&E will deploy a modern LTE cellular-based network solution as part of SM 2.0, defined as meter-to-cloud connectivity. New SM 2.0 electric meters and gas modules will use this network when SM 2.0 electric meters and gas modules are installed. This new network will be supplemented by a micro-mesh in areas where cellular coverage is inadequate. The upgrade will enhance communication capabilities and ensure reliable direct communication between electric meters, gas modules and the SM 2.0 HES.

The new LTE network solution will leverage public LTE networks (*e.g.*, Verizon, AT&T, and T-Mobile), providing SDG&E with enhanced communication resiliency and flexibility. SM 2.0 will also support Wi-Fi connectivity for customer devices, enabling various customer side use cases such as customer insights: real-time energy monitoring. Additionally, the system will utilize the latest mobile technologies, including Firmware Over-the-Air (OTA) management, to keep electric meters updated. Smart meter network support, including network monitoring and vendor management related to cellular carriers will be conducted by the SM 2.0 vendor during and after the deployment, and supported by SDG&E resources.

A vendor proposal estimates that over 99% of endpoints will connect directly to the LTE Wide Area Network (WAN), with the micro-mesh solution covering the remaining endpoints. For endpoints connecting directly to the LTE WAN, the network will utilize embedded

electronic SIM cards (eSIM)[14] to optimize carrier support and allow for automatic failover during cellular carrier outages. For endpoints without WAN connectivity, the micro-mesh will ensure connectivity for electric meters and gas modules located in areas where cell coverage is spotty, or in basements or meter rooms where there is insufficient or no cellular service.

The micro-mesh router product currently available from vendors requires infrastructure such as a wall or pole to mount, as well as AC power to power the router. Dedicated labor resources from the SM 2.0 vendor will be necessary for the installation, testing, and commissioning of the mesh communications network equipment in the field, including upgrades and reconfiguration of communications backhaul equipment.

SDG&E's internal network will employ a Virtual Private Network (VPN), dedicated communication lines or similar technologies to connect the on-premises data center to the cloud-based HES. These technologies will further secure communications that transport operational meter functions, such as remote connect and disconnect.

6. Interim Period - Integration & Infrastructure Updates needed for SM 2.0

In addition to the new systems described above, there are also various integrations with other SDG&E systems that will leverage data from the SM 2.0 systems which will be implemented during the interim period. Most of these integrations originate from the HES as outlined in Figure 5-8 below, but some also integrate with the CIS system. All systems will require SDG&E to work with the SM 2.0 vendor and System Integrator (SI) to provision new integrations to facilitate the new solution. Some SDG&E systems will also require configuration or remediation changes to support the new SM 2.0 systems as outlined below.

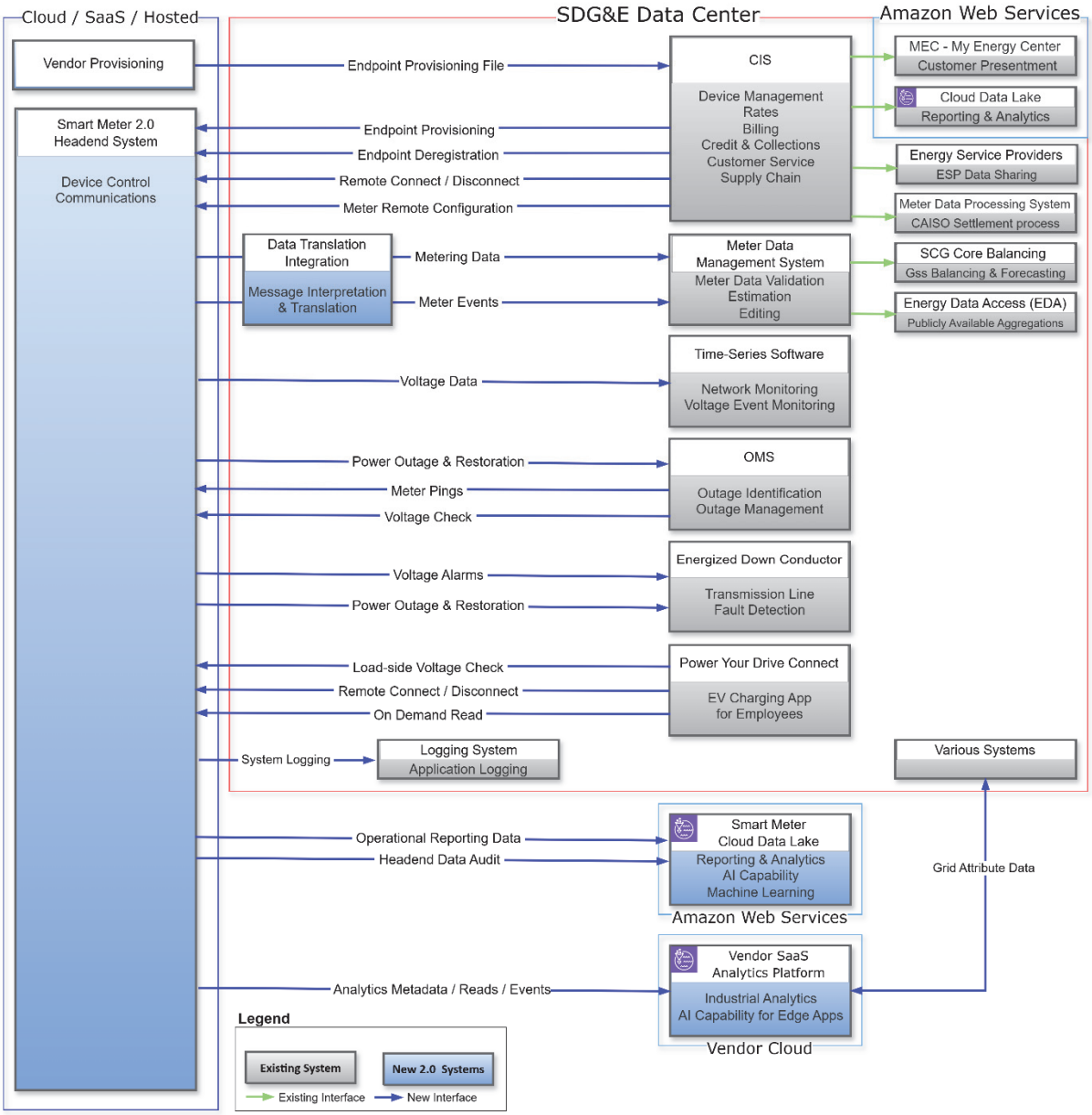
[14] Electronic SIM cards are a digital version of a physical SIM card—identifying devices virtually to provide a network connection.

a. New Integrations

Figure 5-8 below shows the various new integrations needed to accommodate the SM 2.0 systems. The integration of SM 2.0 field data with downstream SDG&E systems will start at the new HES. Each integration will be reviewed to identify compatible capabilities in the new HES's API.

Similar to the current SM 1.0 IT solution, the integrations depicted in Figure 5-8 below leverage smart meter data for various functionalities across the business, such as outage management and enterprise analytics. New integrations include a direct linkage between the HES and the vendor's SaaS analytics platform, as well as a new data translation integration between the new HES and the existing MDMS system. The SM 2.0 systems support streamlined integrations and interoperability with other platforms and reduces vendor-specific integrations by adhering to open industry standards such as MultiSpeak and CIM. These standards enable seamless integrations with various SDG&E back-office systems such as CIS, MDMS, OMS, among others.

Figure 5-8
SM 2.0 Integrations –Foundational and NextGen Technology



b. Interim Period - MDMS System Remediation

The existing MDMS system will need to process data from both the SM 1.0 HES as well as the new SM 2.0 HES in the interim period between initial technology implementation, and completion of SM 1.0 electric meter and gas module replacements with SM 2.0 devices. This will require custom integrations and configuration to ensure the MDMS will work with the new

SM 2.0 HES. System changes for MDMS to support the new SM 2.0 HES will require the following:

- Configure the MDMS to support the new SM 2.0 HES and ensure it can import the required interval and alert and alarm data from SM 2.0 without disrupting existing integrations with SM 1.0 HES.
- Ensure the MDMS database can scale for storage and performance based on the SM 2.0 requirements.
- Implement a new data translation integration to facilitate robust data communication between the SM 2.0 HES and the MDMS.

c. Interim Period – Changes to CIS, Supply Chain, SORT, CPD and Geocall Systems

During the interim period, new integrations and updates will be introduced to the CIS, Supply Chain, Service Order Routing and Tracking (SORT), Construction Planning and Design (CPD), and Geocall (work order system used for large gas meters and module replacements conducted by the gas distribution team) systems. Changes to SDG&E's CIS system include the addition and configuration of new electric meters and gas modules which require thorough testing across various CIS modules such as device management, billing, digital (customer facing portal), credit and collections, and applications such as SORT, CPD, and Geocall. System changes needed to support the foundational technology will require the following:

- A new Advanced Shipping Notification (ASN) file format will be introduced to support SM 2.0 electric meters and gas modules. This format includes additional attributes that must be validated and imported into systems such as Supply Chain, CIS, SORT, and job management platforms.

- SM 2.0 requirements and processes must be configured within the CIS, which will play a pivotal role in coordinating operations across multiple HES platforms. For example, the CIS integration layer will need to know which HES to route remote turn-on and turn-off requests to, depending on which HES the meter is connected. Also, meter provisioning and related services may also be affected and will be adjusted as needed to preserve system integrity and performance.
- New requirements are being introduced to the SORT system, including support for configuring new meters and modules, along with iOS-compatible features that modernize the technician's experience in alignment with other SDG&E field tools. These enhancements also enable photo and coordinate capture, which are essential for downstream processes such as meter connectivity management in the SM 2.0 HES and AI-driven installation validation use cases.
- Because two HES systems will operate during the interim solution, new integrations are needed to ensure remote commands - such as turn-on, turn-off, and ping - are correctly routed to the appropriate HES.
- New integrations will be needed from SDG&E systems to the mass deployment vendor's systems that would also require changes to SDG&E's existing systems and integrations.
- Performance enhancements are required for the integration between MDMS and CIS to accommodate the increased volume of 15-minute, two-channel interval data resulting from a growing number of meters with this configuration. Additionally, infrastructure upgrades, including expanded storage and compute capacity, will be necessary to support the higher volume of interval reads.

- End-to-end testing will be essential to confirm that all impacted processes across CIS, SORT, and Supply Chain end-to-end system processes function as expected.

d. Interim Period - Additional installation validation capability

Field installation crews will be able to capture standardized photos of each meter location, enabling the use of AI to identify and address potential installation issues. Image analysis algorithms can verify that the electric or gas meter has been installed at the correct location by matching visual and geotagged data to the intended service address. This accurate meter location data is also beneficial for utility grid modeling, load forecasting, and advanced programs such as DER integration, outage management, and voltage optimization. For gas module exchanges, AI can also compare pre- and post-installation dial readings to ensure the transfer of usage data is accurate and complete, reducing billing exceptions. This integrated photo and AI validation process enhances installation quality, supports accurate system modeling, improves operational efficiency, and provides a verifiable audit trail for compliance and customer assurance.

e. Required Modifications to other IT Systems to support Foundational Technology

Below is a summary of expected changes and modifications to other downstream SDG&E systems to create the foundational technology in the interim period between initial technology implementation, and completion of mass deployment.

- **Core Balancing** – New integrations will be implemented to accommodate the SM 2.0 HES, along with minor remediations.
- **Meter Shop Activity Portal (MSAP)** – New integrations will be implemented to accommodate the SM 2.0 HES, as well as changes to the application logic. Remediations will be needed to ensure electric meter and gas module testing,

inventory and return metering authorization (RMA) processes work with the new electric meters and gas modules and the SM 2.0 vendor.

- **SDG&E time-series software** – System remediations and new integrations will be implemented to accommodate data sent from the new SM 2.0 HES.
- **Energized Down Conductor (EDC)** – New integrations and remediations will be implemented to accommodate the SM 2.0 HES.
- **Power Your Drive Connect (PYD-C)** – New integrations and remediations will be implemented to accommodate the SM 2.0 HES.
- **Smart Meter Cloud Data Lake** – Operational reporting data from the new SM 2.0 systems will be integrated into the SM cloud data lake, extending the foundation of the SDG&E enterprise cloud data lake, enabling reports and analytics functions in the new platform.
- **OMS** - Integrating the new SM 2.0 HES with the OMS will maintain SDG&E's ability to detect, respond to, and manage power outages in real-time. The OMS system will need to be remediated to integrate with both the SM 1.0 HES and SM 2.0 HES until the SM 1.0 HES is decommissioned.
- **COKE** – Remediations will be needed to manage exceptions in the SM 2.0 HES.
- **Energy Data Access** – Testing is necessary to confirm that existing processes continue to work as expected.
- **Downstream Analytics systems** – A few downstream analytics systems, including the CIS analytics system, load research system and the engineering data warehouse, will require additional storage and testing to ensure end-to-end processes continue to function.

- **Interactive Voice Response (IVR)** – In support of mass deployment, new configurations will be required to ensure calls about SM 2.0 are routed correctly with concise messaging.

C. New Systems Supporting NextGen Capabilities

In addition to new integrations and modifications to existing systems, NextGen technology will also feature a vendor SaaS analytics platform and grid edge applications[15] which can be provisioned by the SM 2.0 vendor or a third party.

Sensors embedded in new SM 2.0 electric meters offer a significant increase in available data to process locally at the meter, and within the vendor's SaaS analytics platform. To turn this granular data into actionable intelligence, SDG&E is proposing the inclusion of grid edge applications installed in the electric meters, as well as a scalable, secure, and pre-integrated vendor SaaS analytics platform. These new systems and grid edge applications will enable the NextGen capabilities:[16]

- Customer Insights: Real-Time Energy Monitoring
- Transformer Health & Load Management
- Meter Transformer Mapping
- Phase Identification

This section will describe new systems and application components needed to enable these NextGen capabilities.

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[15] Grid-edge applications for electric meters are solutions deployed on customer meters—located at the edge of the electric grid—that use advanced metering technologies to deliver NextGen capabilities and analytics.

[16] *See* Chapter 3, II.A.3, "NextGen Technology to Support NextGen Enhanced Electric Capabilities" for additional information on the Enablement of NextGen capabilities.

1. Grid Edge Applications (Software applications installed in the meter)

The new SM 2.0 electric meters SDG&E seeks to deploy are revolutionary compared to current meters, incorporating grid edge computing directly within the meter itself. The most compelling advancement in SM 2.0 electric meter is the ability to process data locally within the meter, commonly referred to as "edge computing." Enabled by embedded processors and software, grid edge computing allows electric meters to process highly granular smart meter data, perform advanced analytics, and transmit targeted data points to the vendor's SaaS analytics platform to support NextGen capabilities. Additionally, meters can take real-time actions locally, such as interacting with behind-the-meter assets like electric vehicle chargers.

The HES platforms support over-the-air deployment of new edge applications to electric meters, access to a catalog of third-party grid edge applications, and enablement of AI processing capabilities to support operational improvements and customer benefits without hardware replacement. Depending on the application and use case, processing may occur at the meter (edge) level but also allow for complementary analytics in the vendor's SaaS analytics platform and SDG&E's IT systems through web service integration or file transfers. Grid edge applications can be pre-installed before deployment or pushed to the meter remotely in the future. Additionally, third-party applications, tested and approved by the SM 2.0 vendor, can also be installed. The data utilized by these applications includes all sensor data available in the meter.

2. Smart Meter – Vendor's SaaS analytics platforms

In addition to grid edge computing applications, new sensor data from SM 2.0 electric meters can be processed and analyzed through a SaaS analytics platform hosted by the SM 2.0 vendor. This platform is designed to ingest data from a broad array of sources, including the CIS, MDMS, HES, Geographic Information System (GIS), and grid edge applications. It

supports the integration of historical and event-driven data streams. Leveraging public cloud services, the platform enables advanced ML and AI capabilities, facilitating the ingestion, processing, and sophisticated analysis of diverse data sources.

D. NextGen Technology

This section describes the specific NextGen technology that SDG&E is proposing to implement that will provide the NextGen capabilities.

Customer Insights: Real-Time Energy Monitoring (Combination of SM 2.0 HES, grid edge applications) – the implementation of the capability will require the deployment of a third-party grid edge application, and associated back-office SaaS platform, to allow customers to monitor their home and device energy consumption in real-time.

The internal IT implementation of this capability involves coordinating IT integrations, cloud infrastructure, and business processes to enable appliance-level energy insights to consumers that opt in for this functionality. Key IT activities include establishing customer enrollment and unenrollment processes, configuring firewalls, cybersecurity and customer privacy evaluations, and designing systems with the third-party solution provider. Once SDG&E residential customers enroll in the program, they can use a downloaded third-party mobile application or vendor web portal to view their disaggregated data.

Meter Transformer Mapping and Phase Identification (Combination of vendor's SaaS analytics platform and grid edge applications) Meter transformer mapping and phase identification allows electric meters to automatically identify their connection points on the distribution network, including specific transformers and electric phase.

The IT implementation of meter transformer mapping and phase identification involves integrating systems, migrating data, procuring added capacity in the meter-to-cloud LTE network, and ensuring business readiness. GIS and CIS data must be consolidated into the

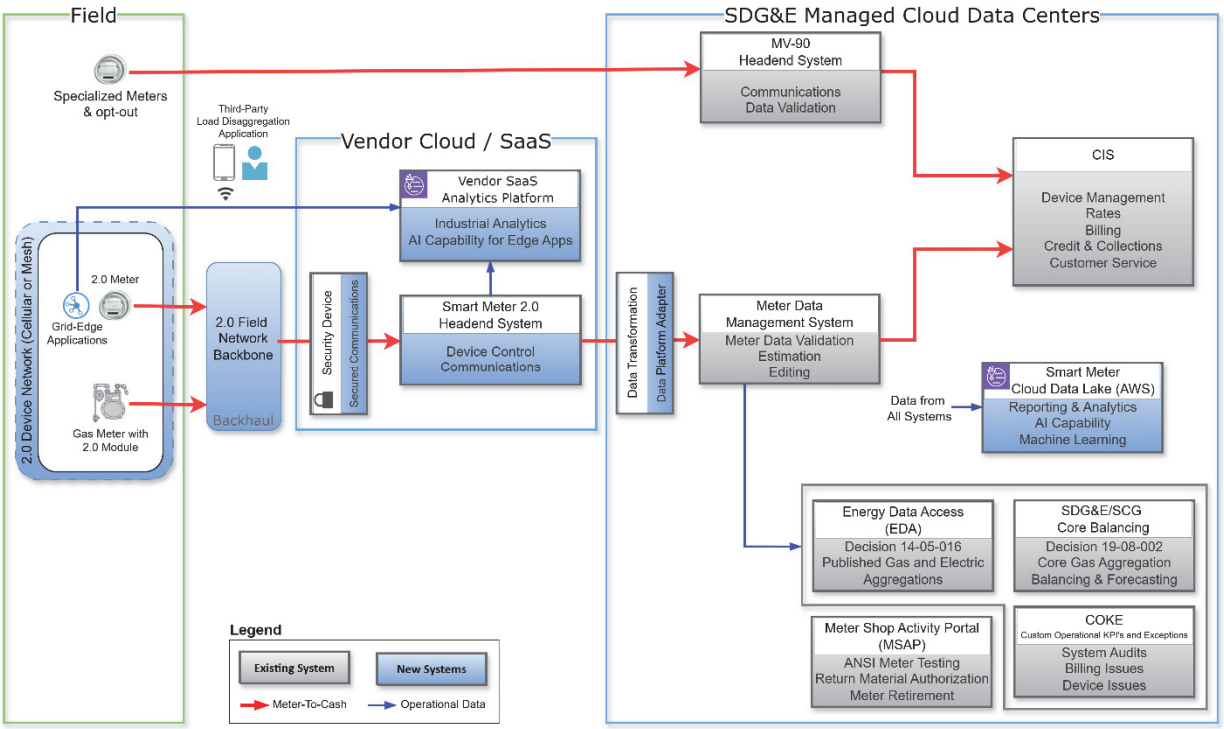
vendor's SaaS analytics platform to create a baseline connectivity model. Advanced analytics will identify discrepancies, which will be manually validated before transitioning to automated verification. Corrections can then be sent back to GIS, CIS, and OMS systems via APIs to maintain accurate models. This will require coordination with the vendor for configuration and testing.

Transformer Health & Load Management (vendor's SaaS analytics platform) As described above, the meter transformer mapping will provide an accurate connected model. Adding transformer attributes to the model allows accurate aggregation of meter consumption data, enabling better assessment of transformer loading and more precise estimation of asset degradation over time.

E. Future State Foundational and NextGen Technology Architecture (Billing Operations Process)

Figure 5-9 below shows the end state after the SM 2.0 electric meters, gas modules and network are fully deployed, in-scope functionality is enabled, and the SM 1.0 systems have been decommissioned. This diagram includes the new grid edge applications and the vendor's SaaS analytics platform to deliver NextGen functionality and use cases.

Figure 5-9
Future State Solution for Foundational and NextGen Technology



F. SM 1.0 Systems to be Retired after SM 2.0 Implementation.

As mentioned previously, the following systems will be decommissioned after being replaced with new systems. The systems to be decommissioned are detailed below:

1. HES & Integration Decommissioning

The SM 1.0 HES, hosted in the SDG&E data center and will be retired when it is no longer needed to support SM 1.0 electric meters and gas modules. All associated integrations will also be retired.

2. Hardware Security Module Decommissioning

With the decommissioning of the SM 1.0 HES, the hardware security module, hosted in the SDG&E datacenters, will no longer be needed and will also be retired.

3. SM 1.0 Network Decommissioning

The current SM 1.0 mesh network and Zigbee gas module network will no longer be needed with the introduction of the SM 2.0 LTE cellular network and will be retired when it is no longer needed to support SM 1.0 electric meters and gas modules.

4. Smart Meter Data Mart Decommissioning

The SM data mart will be superseded by the SM data lake and will be retired along with its associated interfaces.

G. Data Governance and Privacy for the Foundational and NextGen Technology

Data governance for foundational and NextGen technology will be directed according to the requirements and governance framework as established by the enterprise cloud data lake & governance team. This framework safeguards the accuracy, security, and privacy of data while also enabling analytics that use smart meter and grid edge data.

SDG&E's data governance strategy emphasizes development of data as a product assigning custodial responsibility for data quality and access control to the applicable team, while teams that consume data are responsible for preserving security and privacy for data they access. This established matrix of roles and responsibilities reduces the risk of security and quality issues stemming from miscommunication.

The enterprise cloud data lake & governance team maintains a data platform that supports effective data product development, publication, and governance relating to the enterprise cloud data lake. With a centralized data catalog and automated processes, the platform simplifies governance, removes technical barriers, enforces security tagging, and ensures data quality and uniqueness within the enterprise.

The enterprise cloud data lake and governance group will collaborate with SDG&E's internal AMI program stakeholders, including, but not limited to cybersecurity and the Office of Customer Privacy (OCP), to ensure that the implemented data processing and analytics capabilities align with standards and are safeguarded, retained, and accessible to relevant business groups.[17]

IV. CONCLUSION

The AMI program represents a critical modernization effort by SDG&E to update its aging smart meter systems and associated IT infrastructure. This testimony outlines the technology and network investments necessary to support the transition from legacy technology to the new AMI foundational and NextGen technology, while maintaining continuity of service and data integrity throughout the transition.

At its core, the AMI program is about ensuring SDG&E can continue to deliver safe, reliable, and secure energy services to customers while preparing for future demands. The proposed updates to IT and the network will replace outdated systems with modern, cloud-based solutions that improve performance, enhance cybersecurity, and enable advanced capabilities such as event-driven data analytics and grid-edge applications. These improvements will allow SDG&E and its customers to better manage energy usage, respond to outages more effectively, and support customer programs like solar integration and electric vehicle charging.

Importantly, the testimony also addresses the need to update legacy technology during the transition period. This includes system updates to current SM 1.0 systems and targeted investments to mitigate SM 1.0 network coverage issues.

[17] *See* Chapter 4, III.B, "Governance and Program Management" for additional information on Customer Privacy.

These activities are essential to support SM 2.0 gas module and electric meter replacements, integrate them into SDG&E's existing systems, and enable future-facing capabilities that benefit both customers and grid operations.

By approving this application, the Commission will empower SDG&E to modernize its metering infrastructure in a way that is secure, scalable, and aligned with California's energy policy goals—while ensuring transparency, reliability, and value for customers.

This concludes my prepared direct testimony.

V. WITNESS QUALIFICATIONS

My name is Bradley M. Baugh, and I serve as a Senior Group Product Manager at SDG&E. My business address is 4949 Greencraig Lane, San Diego, California, 92123. In my current role, I lead SDG&E's Customer Field and Emergency Management Information Technology organizations. These teams are responsible for delivering innovative, people-focused, secure, and resilient technology solutions that support key areas including the AMI Program, Legacy Smart Meter Activities, Clean Transportation, and Emergency Management. I was appointed to my current role in November 2021. Since joining SDG&E in 2003, I have held a series of positions of increasing responsibility across Information Technology and Customer Services. Prior to joining SDG&E, I held positions at Sierra Systems Consulting Group, GS Lyon Consulting, and Andersen Consulting.

I have a Bachelor of Science in Business Administration Degree (Finance & Banking), a Bachelor of Science in Business Administration Degree (Economics), and a Bachelor of Science in Accountancy Degree from the University of Missouri – Columbia in 1992.

I have previously testified before the California Public Utilities Commission.