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Data-Center Infrastructure Substrate: Collapsing UPS Rooms, Cooling Distribution, and Raised-Floor Wiring Into One Credentialed Structural Surface

Hyperscale, colocation, and edge data centers stack four separate capital systems on top of each other: a structural shell, an uninterruptible-power-supply battery room, a chilled-fluid distribution network, and a raised-floor electrical plane, each sited, permitted, and serviced independently. This application collapses those systems into a single load-bearing surface, built on the Credentialed Surfaces inventive step, disclosed in U.S. Provisional Application No. 64/050,895. The result is a foundation, wall, and raised-floor substrate that also carries facility ride-through energy, a low-voltage DC bus, a facility data network, and a direct-to-chip liquid-cooling interface as credentialed properties of the concrete itself.

What This Application Specifies

A data center is, at heart, a building whose structural mass has always been treated as inert. The foundation holds up the racks, the walls enclose the hall, and the raised floor carries cabling and airflow. Every energy, cooling, and power-distribution function is then bolted on as a separate device or plant sited beside that inert structure. This

application specifies a different arrangement in which the structural concrete of a facility is itself a credentialed substrate that carries energy, power distribution, data networking, and thermal coupling as declared properties of the material.

The home inventive step is the Credentialed Surfaces architecture disclosed in U.S. Provisional Application No. 64/050,895. Its core move is an architectural inversion: instead of energy storage being a property of dedicated battery devices installed as equipment, storage becomes a credentialed property of structural building materials, distributed across mass that would be poured for structural reasons anyway, and aggregated by a building energy management system as a coherent resource. The same inversion applies to electrical distribution, data networking, and thermal coupling. Each function is expressed as an independently credentialed admissibility surface on the material, and the surfaces compose through signed, versioned composition rules.

For data centers specifically, the disclosure names a data center substrate deployment. In it, a facility's foundation, lower wall sections, raised-floor structural panels, and inter-rack structural elements are formed as credentialed cementitious-graphene composite that simultaneously carries a structural admissibility surface, an energy storage admissibility surface operating as uninterruptible-power-supply substrate with capacity attestations sized to declared facility ride-through requirements, a distribution admissibility surface operating as a low-voltage DC bus, a data network admissibility surface operating as a facility-internal data network, and a thermal admissibility surface operating as a direct-to-substrate liquid-cooling heat-rejection interface for liquid-cooled or direct-to-chip-cooled information-technology equipment. The disclosure frames the combined-function infrastructure as replacing the prior separate UPS battery rooms, dedicated cooling distribution units, raised-floor electrical distribution, and structural foundation with a single credentialed substrate.

Why It Matters

Data-center capital and floor area are consumed disproportionately by systems that never process a single workload. UPS battery rooms occupy conditioned, fire-rated space and carry their own replacement and thermal-runaway management burden. Cooling distribution units, pumping skids, and the piping that feeds them are a second parallel plant. Raised-floor electrical distribution is a third. Each is separately sited, separately permitted against a different code chapter, separately commissioned, and separately serviced across the facility's life. The building shell that holds all of this is, meanwhile, doing structural work only.

Treating structure as inert forces every other function to be duplicated as a device. The inversion in this application lets the mass do more than one job. Ride-through energy lives in the same concrete that carries load. The chilled fluid that rejects heat from direct-to-chip loops is the same engineered electrolyte phase that supports the storage surface. Power reaches racks through conductive planes integrated into structural panels rather than through a separately built distribution layer. Because each function is a credentialed surface rather than a bolted-on box, the facility's operator, the authority having jurisdiction, and the utility each evaluate the property they care about against a profile that travels with the material, without the four systems having to be reconciled after the fact.

How It Composes With the Domain

The composition follows the surfaces the disclosure defines, mapped onto the four things a data hall needs from its structure.

Structure and ride-through energy share the same body. The disclosed substrate-mode storage places energy capacity in the cementitious-graphene composite through turbostratic graphene distributed in the structural matrix, with an ionic-mobility medium supplied either by the cement pore solution or by an engineered electrolyte

phase held in sealed cavities. The energy storage admissibility surface declares realized capacity, and for this deployment the disclosure ties those capacity attestations to declared facility ride-through requirements. The primary chemistry class in the disclosure is a carbon-only capacitive class, which the specification describes as having no thermal-runaway pathway beyond the structural matrix's native fire performance. That property is directly relevant to a function whose current implementation, a room full of electrochemical devices, is precisely the fire and containment problem operators plan around.

Thermal coupling and storage share the same fluid. The disclosed thermal-coupling substrate primitive lets a single credentialed element act at once as a structural body, a storage body, a thermal-mass body, and a heat-exchange surface. In the closed-cell cavity-bath configuration, the same fill-and-drain manifold that distributes the engineered electrolyte phase also operates as a thermal-management hydronic loop. For a hall running liquid-cooled or direct-to-chip equipment, the structural panels become the heat-rejection interface, and the disclosure describes rejecting substrate operating heat to a ground loop or ambient-air radiator and recovering round-trip-efficiency losses back into the facility's conditioning systems. The disclosure also describes low-global-warming-potential refrigerant heat-pump coupling, with the hydronic-loop tubing wall providing primary pressure containment and the surrounding composite acting as confinement and thermal-coupling medium.

Distribution runs as a DC surface. The disclosed panel-as-distribution-substrate primitive gives a structural panel a distribution admissibility surface: conductive layer planes, a declared voltage class, per-zone current limits, per-zone fault isolation, and an electrical-code-compliance attestation. Operating voltages typically below 60 volts DC place substrate operation in the Class 2 or Class 3 wiring regime under NFPA 70 Article 725. In a data center, this is the raised-floor plane and the inter-rack elements delivering low-voltage DC to equipment through credentialed surface attachment, with per-zone isolation interrupting only the affected zone under fault.

Networking rides the same panels. The disclosed panel-as-network-substrate primitive gives a panel a data network admissibility surface with declared data classification, per-source and per-destination rate ceilings, permitted destinations, and retention requirements, carried over power-line modulation, dedicated data layers, or panel-resident RF. For a facility, this composes the structural panels into a facility-internal data network whose admission of traffic is governed by composite evaluation across those surfaces.

Governing all four, a building energy management system discovers the credentialed elements, characterizes and attests their state of health, aggregates capacity into a coherent resource, and dispatches under composite admissibility evaluation. Composition rules mediate conflicts: the disclosure gives a fire-event rule that reduces storage admissibility to zero when the fire-performance surface declares a fire event, and thermal and structural derating rules that constrain dispatch under adverse conditions. That governance is what lets one physical element safely serve four historically separate jobs.

What This Enables

Reclaimed floor and reduced parallel plant. When ride-through energy, cooling distribution, and power distribution are properties of the structure, the separately sited UPS room, cooling distribution units, and raised-floor electrical plane no longer need to be built as independent systems occupying their own space and carrying their own permitting.

Ride-through without a battery-device fleet. Because the primary capacitive class stores energy in the electric double layer on graphene surfaces rather than in extractive metal active species, the disclosure describes it as carrying no thermal-runaway pathway beyond the matrix's native fire performance, and its declared charge-discharge time scales of seconds to minutes align with the ride-through window a facility bridges before generators or utility restoration take over.

Heat recovery instead of pure rejection. The Joule-loss-recovery configuration extracts round-trip-efficiency losses from the substrate through the same manifold and returns them to space-conditioning or hot-water systems, and the ground-loop and ambient-air-radiator configurations give a facility passive and low-lift paths for the heat that dense compute rejects.

An auditable material record. Each element carries a credentialed admissibility profile and a lineage chain across manufacturing, installation, in-service operation, and end-of-life, with independent authorities signing the surfaces in their scope. For operators subject to structural, electrical, fire, and environmental review, the property each reviewer evaluates travels with the material rather than being reconstructed from as-built drawings of four separate systems.

Grid participation and edge parity. The disclosed building energy management system can offer duration-attested commitments for grid services and federate across facilities, and the scale-invariant primitive means the same architecture that serves a hyperscale hall also serves a colocation or edge facility, where reclaimed space and fewer parallel systems matter most.

Boundary Conditions

This application is a provisional disclosure. Nothing here is built, benchmarked, or field-validated, and no performance claim beyond the ranges recited in the specification should be read into it; where numbers appear, they are disclosed or projected ranges, not measured results. The underlying materials science, turbostratic graphene, flash Joule heating, electric-double-layer storage, cementitious composites, and hydronic thermal mass, is pre-existing. The novelty asserted is the architecture and the combination: structural material carrying independently credentialed, composing property surfaces, not a new discovery in basic materials science.

The chemistry sets honest limits. The primary capacitive class is a low-energy-density, high-cycle-life, seconds-to-minutes resource by the specification's own ranges, well matched to short ride-through and power-quality duty but not a substitute for multi-hour dedicated storage without extension classes that the disclosure itself notes carry trade-offs. Realized storage capacity scales with structural mass, so ride-through sizing is bounded by how much credentialed structure a given facility actually pours. The specification recites electrical-code framing, including grounding, bonding, arc-flash and shock protection, fault isolation independent of the management system, and the Class 2 or Class 3 characterization under NFPA 70 Article 725; those are disclosed design conditions, and any real deployment is subject to the authority having jurisdiction. Data-center power, cooling, and reliability standards, and their qualification, commissioning, and tier-rating regimes, are external to this disclosure and are not represented as satisfied by it.

Disclosure Scope

The inventive subject matter described here, credentialed structural surfaces carrying energy storage, electrical distribution, data networking, and thermal coupling as composing admissibility surfaces of building material, together with the named data center substrate deployment, is disclosed in U.S. Provisional Application No. 64/050,895. All statements about what the invention does trace to that disclosure. The data-center domain framing in this article, including references to UPS ride-through, liquid and direct-to-chip cooling, colocation and edge facility types, and the NFPA 70 wiring classes, is external enabling context describing the real-world environment into which the disclosed architecture composes; it is provided to illustrate application and does not expand the scope of the disclosure, and regulatory, code, and standards references are cited as external context whose applicability to any deployment is determined by the relevant authorities rather than asserted here.

Credentialed Surfaces (/credentialed-materials)

All 40 steps → (/inventive-steps)

Building surfaces as credentialed agents that participate in the structure's networking and electrical systems.

Provisional application

PRIMARY TECHNICAL DISCLOSURE

- Credentialed Building Materials: Cryptographic Admissibility for Structural Surfaces (/articles/credentialed-building-materials-cryptographic-admissibility-for-structural-surfaces)

SECONDARY TECHNICAL

- Carbon-Sequestration Admissibility Surface (/articles/credentialed-materials/carbon-sequestration-property-surface)
- Composition Rules Governing Surface Interactions (/articles/credentialed-materials/composition-rules)
- Decommissioning And Re-Credentialing Attestation (/articles/credentialed-materials/decommissioning-and-recredentialing)
- Electrical-Distribution Admissibility Surface (/articles/credentialed-materials/distribution-property-surface)
- End-Of-Storage-Life Attestation (/articles/credentialed-materials/end-of-storage-life-attestation)
- Energy-Storage Admissibility Surface (/articles/credentialed-materials/energy-storage-property-surface)
- Lineage Chain Across Material Lifecycle (/articles/credentialed-materials/lineage-chain-across-lifecycle)
- Authority Signatures Block Binding Property Surfaces To Material Identity (/articles/credentialed-materials/master-credential-binding)
- Multi-Authority Signature Block (/articles/credentialed-materials/multi-authority-signature-block)
- Data Network Admissibility Surface (/articles/credentialed-materials/network-property-surface)
- Profile Versioning Continuity (/articles/credentialed-materials/profile-versioning-continuity)
- Structural Admissibility Surface (/articles/credentialed-materials/structural-property-surface)
- Thermal-Property Admissibility Surface (/articles/credentialed-materials/thermal-property-surface)
- Versioned Admissibility Profiles With Lineage Chain (/articles/credentialed-materials/versioned-profiles-with-lineage)

- Water-Coupled Admissibility Surface (/articles/credentialed-materials/water-coupled-property-surface)

APPLICATIONS · GENERAL

- Credentialed Structural Materials for Construction and Civil Infrastructure: Carrying Strength, Mix, and Provenance as Multi-Authority Attestations (/articles/credentialed-materials/construction-and-infrastructure)
- Carbon-Credit-Bearing Building Materials: Sequestration Attestations That Survive Incorporation, Transfer, and Decommissioning (/articles/credentialed-materials/carbon-credit-materials)
- Building-Product Compliance and Code Approval: Property-Surface Profiles as Machine-Evaluable Admissibility Evidence (/articles/credentialed-materials/building-product-compliance)
- Credentialed Building Materials for Real Estate Valuation, Insurance, and Disclosure: A Property History That Binds to the Asset (/articles/credentialed-materials/real-estate-and-asset-lifecycle)
- Recredentialing Recovered Materials: Verifiable Lineage for Reuse and Decommissioning in the Circular Economy (/articles/credentialed-materials/circular-economy-and-decommissioning)
- Energy and Grid-Coupled Surfaces: Crediting Stationary Storage in Structural Mass Without Trusting the Cell (/articles/credentialed-materials/energy-and-grid-surfaces)
- Credentialed Surfaces for Water and Environmental Infrastructure: Signed Performance and Compliance Attestations on Water-Coupled Concrete (/articles/credentialed-materials/water-and-environmental-infrastructure)
- **Data-Center Infrastructure Substrate: Collapsing UPS Rooms, Cooling Distribution, and Raised-Floor Wiring Into One Credentialed Structural Surface (/articles/credentialed-materials/data-center-infrastructure)**
- Turning EV-Charging Sites Into Structure: Credentialed Substrate That Stores, Distributes, and Settles Power in the Slab (/articles/credentialed-materials/ev-charging-infrastructure)

APPLICATIONS · SPECIFIC

- Circularise, a blockchain-based supply-chain traceability and digital-product-passport platform for materials vs credentialed material surfaces: attestations bound to the physical material (/articles/credentialed-materials/circularise)
- EC3 (Embodied Carbon in Construction Calculator) by Building Transparency vs a credentialed carbon-sequestration surface bound to the material (/articles/credentialed-materials/ec3-building-transparency)
- CarbonCure Technologies, which injects and mineralizes CO2 into concrete during mixing vs a credentialed carbon-sequestration attestation architecture (/articles/credentialed-materials/carboncure)

- Sublime Systems, maker of low-carbon cement via an electrochemical (ambient) process vs a credentialed carbon-sequestration surface bound to the material (/articles/credentialed-materials/sublime-systems)
- Brimstone carbon-negative portland cement vs credentialed material attestations: process decarbonization or per-element carbon accounting? (/articles/credentialed-materials/brimstone)
- The EU Digital Product Passport (DPP) under the Ecodesign for Sustainable Products Regulation (ESPR) vs credentialed surfaces: a data-carrier standard next to a material-bound attestation architecture (/articles/credentialed-materials/eu-digital-product-passport)
- One Click LCA, a life-cycle-assessment and EPD software platform for construction vs a credentialed carbon-sequestration property surface bound to the material (/articles/credentialed-materials/one-click-lca)
- Concrete.ai vs credentialed carbon-sequestration surfaces on structural materials (/articles/credentialed-materials/concrete-ai)
- Madaster alternative: material passports as a building registry vs credentialed surfaces bound to the physical material (/articles/credentialed-materials/madaster)

Credentialed Surfaces overview → (/credentialed-materials)