

Integrating Solid State Transformer (SST) to Data Center LVDC Ecosystem



Satarupa Bal *Senior Power Electronics Engineer, Google*

Ashish Upreti *Staff Power System Engineer, Google*

Mike Tu *Principal Electrical Engineer, NVIDIA*

Agenda

01
Why Solid State Transformer (SST) for LVDC

02
LVDC Architecture Options

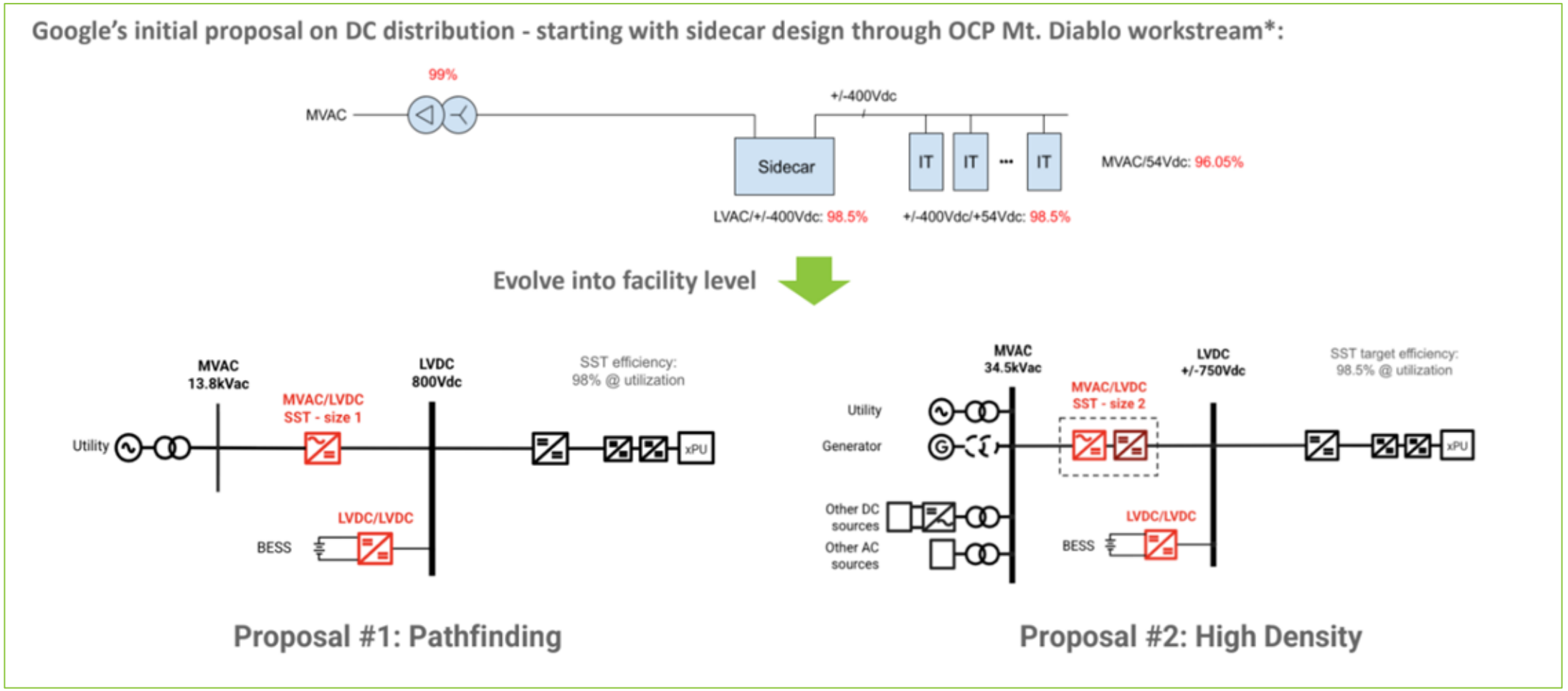
03
Alignment on Specification

04
Specification Flexibility

05
Next Steps

06
Call for Action

Next Generation LVDC Architecture



* Snapshot from "*Low-Voltage Direct Current Distribution with Solid State Transformer*", presented by Jing Wang, Krishnanjan Ravikumar, Google, in OCP Summit 2025

Why DC Distribution and SST

Centralized Power Conversion

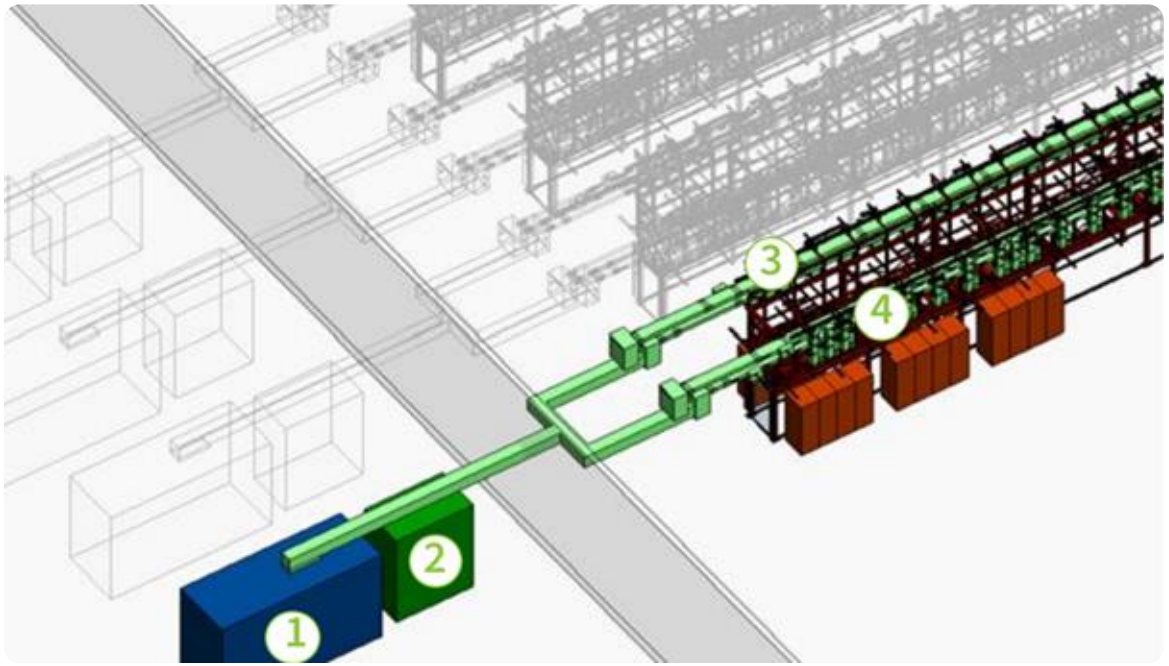
Moves conversion units outside the Data Center Hall (DCH) to maximize premium space for AI/ML load racks.

Increased Flexibility

Enables greater adaptability in terms of rack types and connection configurations.

Consolidated Backup

Combines hundreds of in-rack batteries into a centralized row-level system for backup and load fluctuation mitigation.



1 **Centralized SST**

2 **Energy Storage System (ESS)**

3 **DC Distribution**

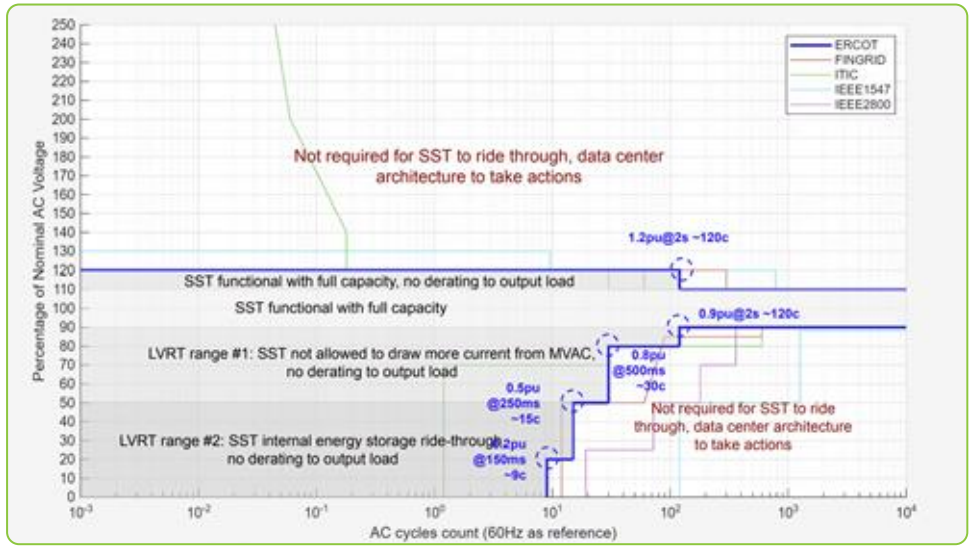
4 **DC Protection**

* Snapshot from "*LVDC - Powering the Future Data Center: A Call to Action on Standardization and Native Designs*", presented by Jason Adrian, Krishnanjan Ravikumar, Google, in OCP EMEA Summit 2026

SST Specification Rev 0.3: LVRT Requirement

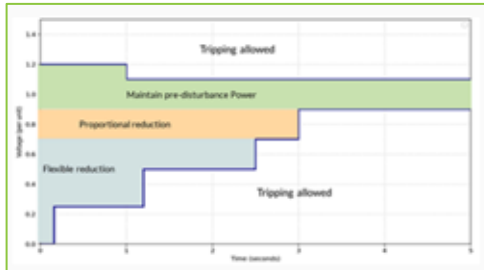
Grid VRT Requirements

Blue line is the new ERCOT Requirement



Voltage Ride Through the SST must meet

SST compliance and capability profile



0.90 – 1.20 pu	CONTINUOUS RANGE	Maintain pre-disturbance active power. Control stability is mandatory. No power reduction is permitted between 0.9 and 1.2 pu.
0.70 – 0.90 pu	MANDATORY RECOVERY	Active power reduction is permitted but must be proportional. Restoration of ≥90% power is required within 1s of recovery.
< 0.70 pu	STABILITY PRIORITY	Flexible power reduction is allowed to maintain synchronization.

Phase Jump

Remain connected for sudden phase angle changes up to 25°.

V/Hz Limit

Ride through 1.1 pu for 45s or 1.18 pu for 2s.

Consecutive

Must handle three voltage disturbances within 10 seconds.

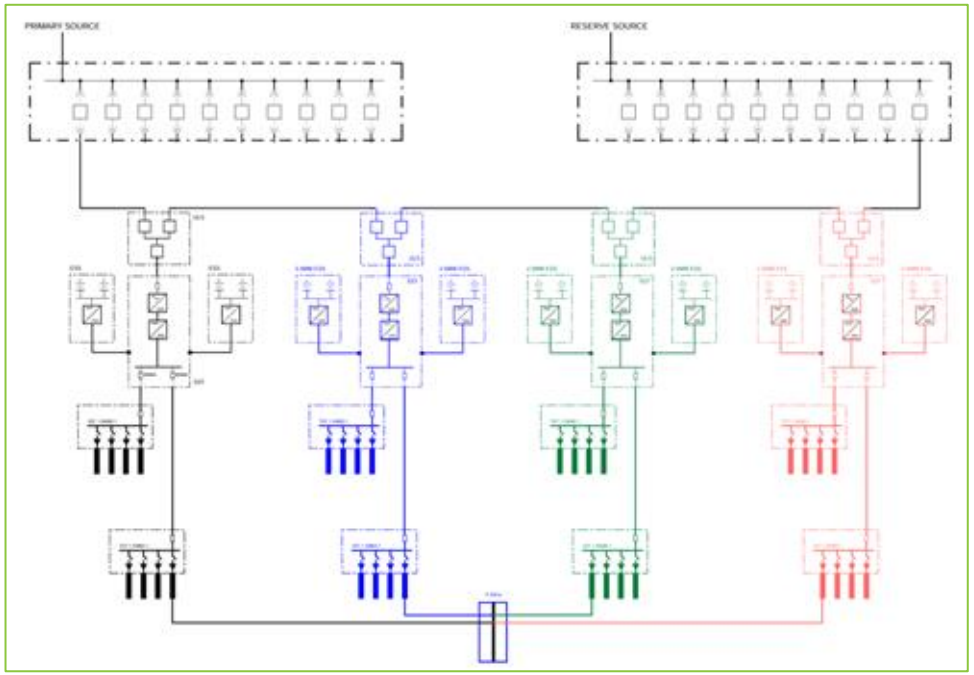
Transient VRT

No tripping for normal system events like faults or switching

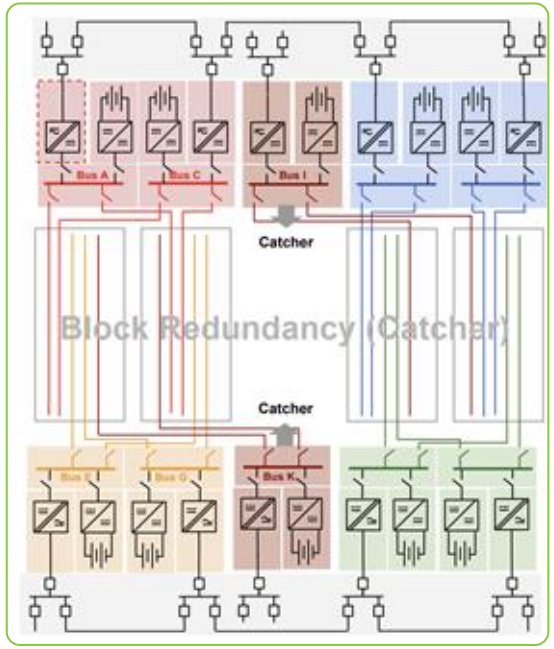
Compliance Mandate

Solid-State Transformers (SSTs) must satisfy stringent Over-Voltage Ride-Through (OVRT) and Low-Voltage Ride-Through (LVRT) compliance standards.

SST Specification Rev 0.3: LVDC Architectures



Distributed Redundancy Architecture



Catcher-Based Architecture

Energy Storage is a critical part of LVDC Architecture to support:

a) AC Side: Utility Requirements such as Voltage Ride Through (LVRT) and Ramp rate.
b) Load Side: Backup power and ML load fluctuation mitigation.

SST Specification Rev 0.3: Alignment

Electrical & Performance

DC Output Interface
800 Vdc Unipolar output

Voltage Tolerances & Regulation
±0.5% (switching freq. ripple) / ±1% static / ±3% dynamic (TBD)

Overload Requirement
120% for 5s / Downstream protection: 150% for ~150ms

Efficiency & Ramp Rate
Eff: ≥98% (50-100% load) | Ramp: 20~50 MW/min

System & Physical Specs

DC Side Grounding
Ungrounded or HRG for LVDC side *(ground fault detection required)*

Dimensions
Physical envelope range: 10-20’ L x 8’ D x 8.5’ H

Environment
Equipment Rating, Design Life, Humidity & Elevation

Compliance
Creepage, Clearance, Safety & EMI compliance

SST Specification Rev 0.3: Flexibility

SKU A

MVAC Voltage
13.8 kVac ± 10%

Power Rating (DC output)
5 MW

Short Circuit Fault Current
18-40 kA symmetrical RMS
104 kA asymmetrical

Basic Impulse Level (BIL)
≥110 kV @ 13.8 kV

SKU B

MVAC Voltage
34.5 kVac ± 10%

Power Rating (DC output)
5 MW, 10 MW

Short Circuit Fault Current
20-50 kA symmetrical RMS
130 kA asymmetrical

Basic Impulse Level (BIL)
≥150-200 kV @ 34.5 kV

NOTE: The 2 SKUs are defined to accommodate the different MV side Voltages between hyperscalers. The subsequent revisions will be built on these 2 SKUs ONLY.

Looking Ahead : Key Milestones and Timeline

Release Focus

Spec Rev x.x

Key technical specifications and system-level requirements included in the next milestone release.

01 Interface Specification for AC and DC sides

02 Telemetry and communication improved definitions

03 Medium Frequency Transformer (MFT) Partial Discharge (PD) requirements

04 Networking Requirements

05 System-level control for LVDC-level fluctuation mitigation

Call to Action

Ecosystem Drive

Joint Effort

Calling for joint collaborative efforts to drive the data center LVDC engineering ecosystem development.

01

SST Specifications Feedback

Requesting feedbacks on the SST Specifications Rev 0.3 from Industry and Academia.

SST Specification : SST Specification Rev 0.3

02

Build Test Case Libraries

Requesting community collaborators to collectively build test case libraries covering:

- MV power quality from various types of energy sources
- LV load profile from different rack types running training or inference workloads

Thank You!

