Consideration of Resistance with Shared Power Line for High Current Device

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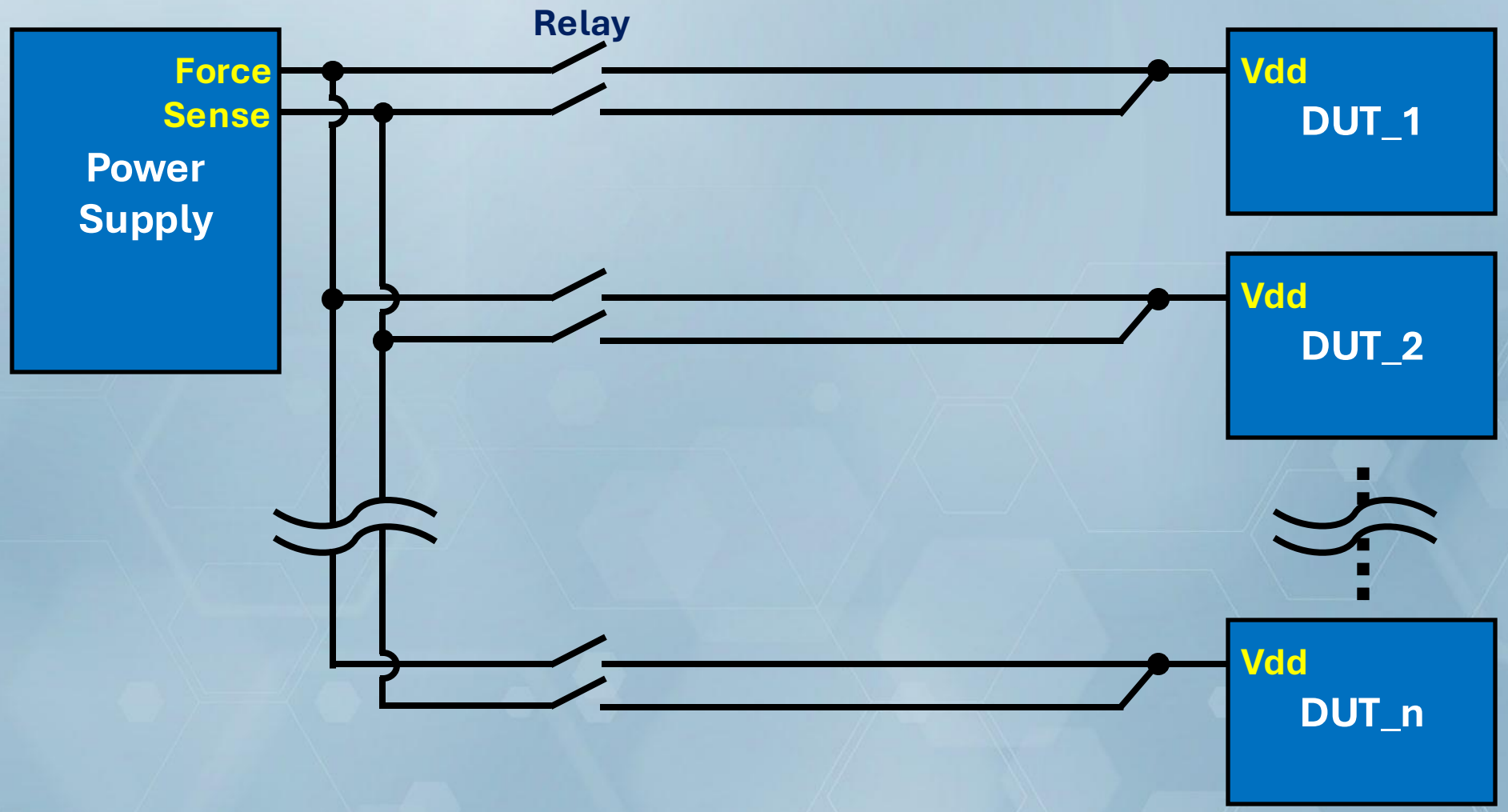
Overview

- Background
- General schematic and sense function
- Problem statement and realistic example
- Solutions and Ask of the industry
- Summary

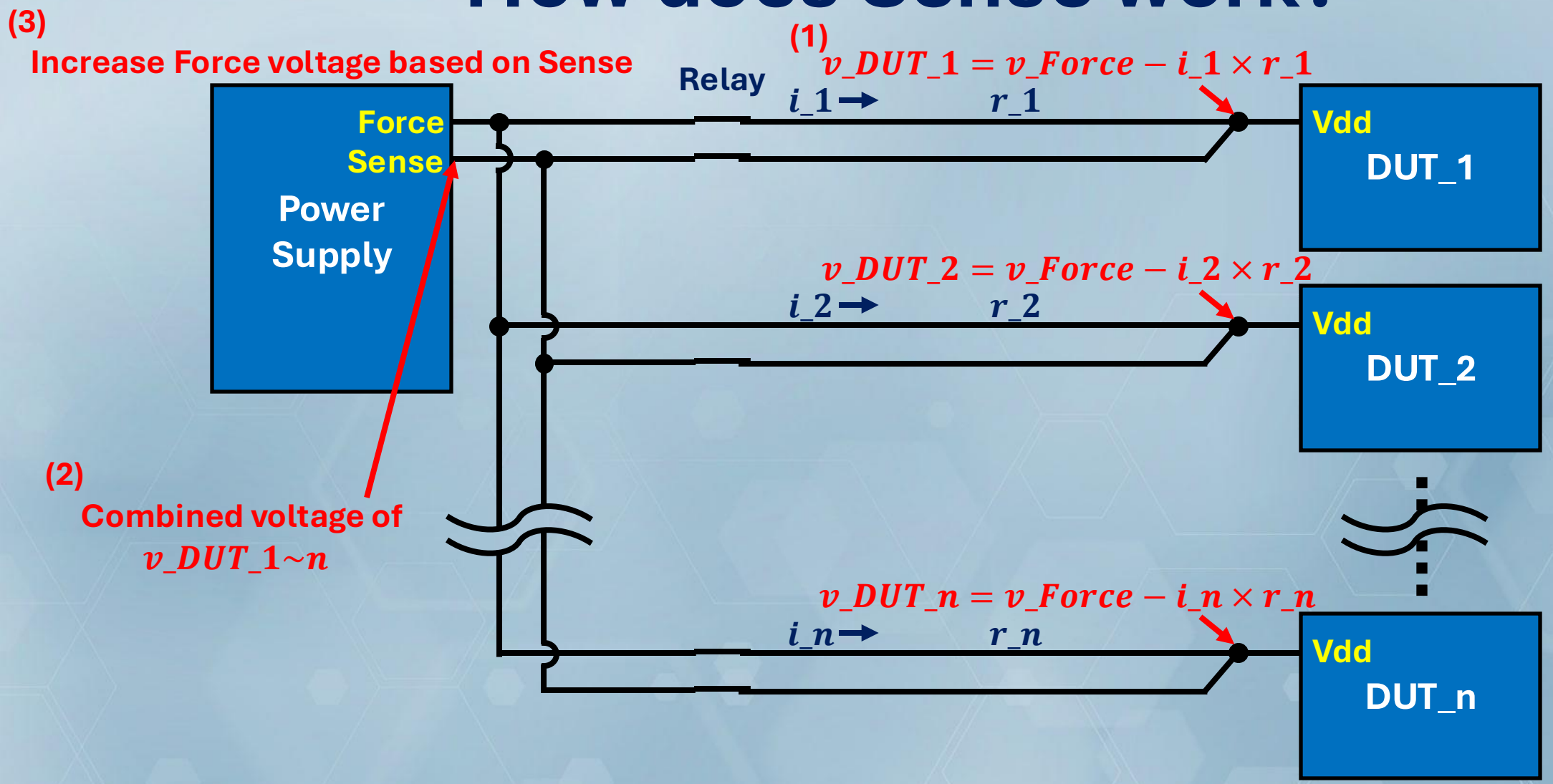
Introductory Background

- Increasing parallelism is required to reduce test costs.
- Sharing the tester resources is required to increase parallelism.
- Not only drivers / IOs but also device power supplies are required to share.
- Understanding & managing shared power supply with high current devices is challenging.
- These challenges will be highlighted in this presentation.

General Schematic of Shared Power Supply



How does Sense work?



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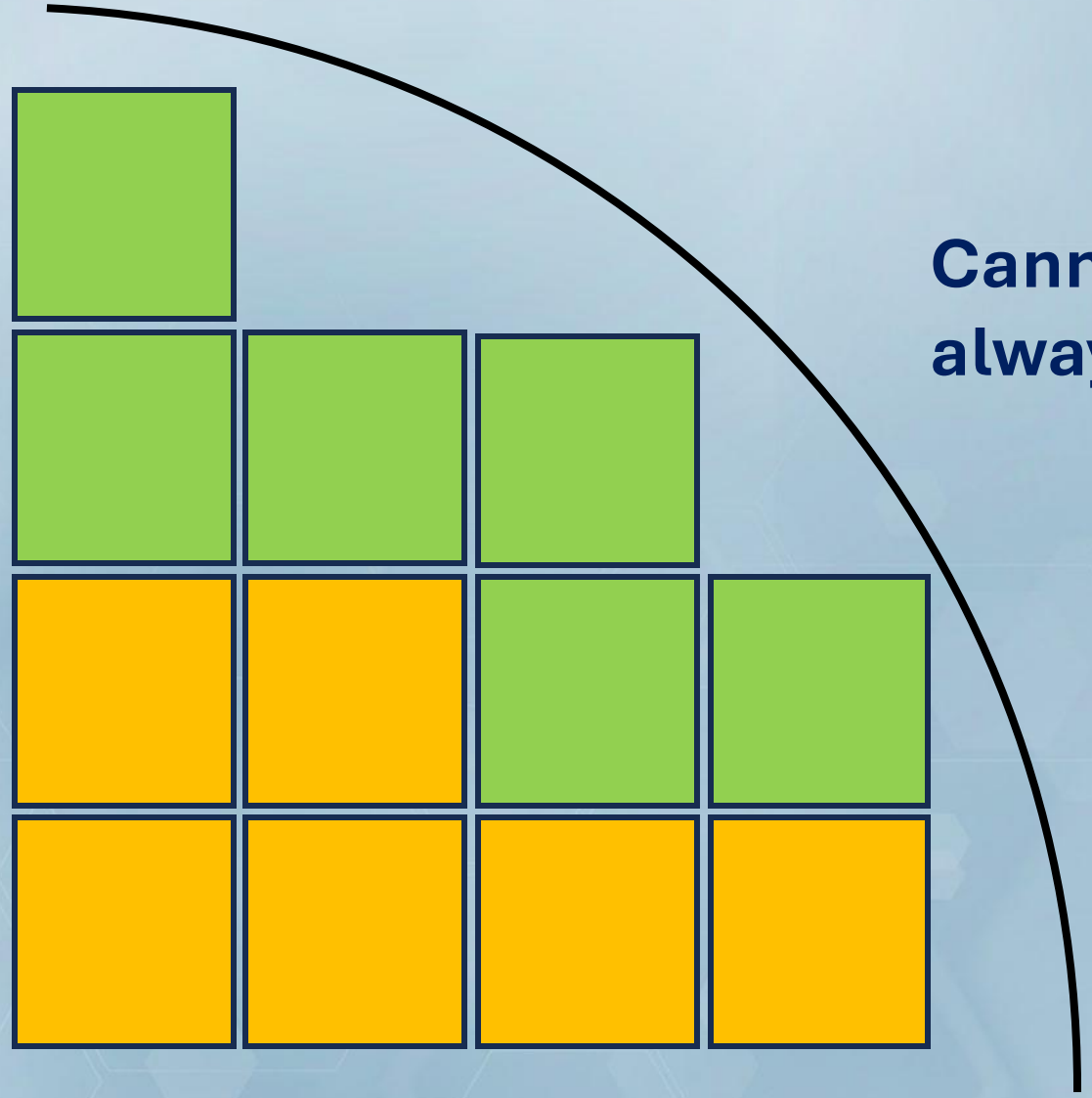
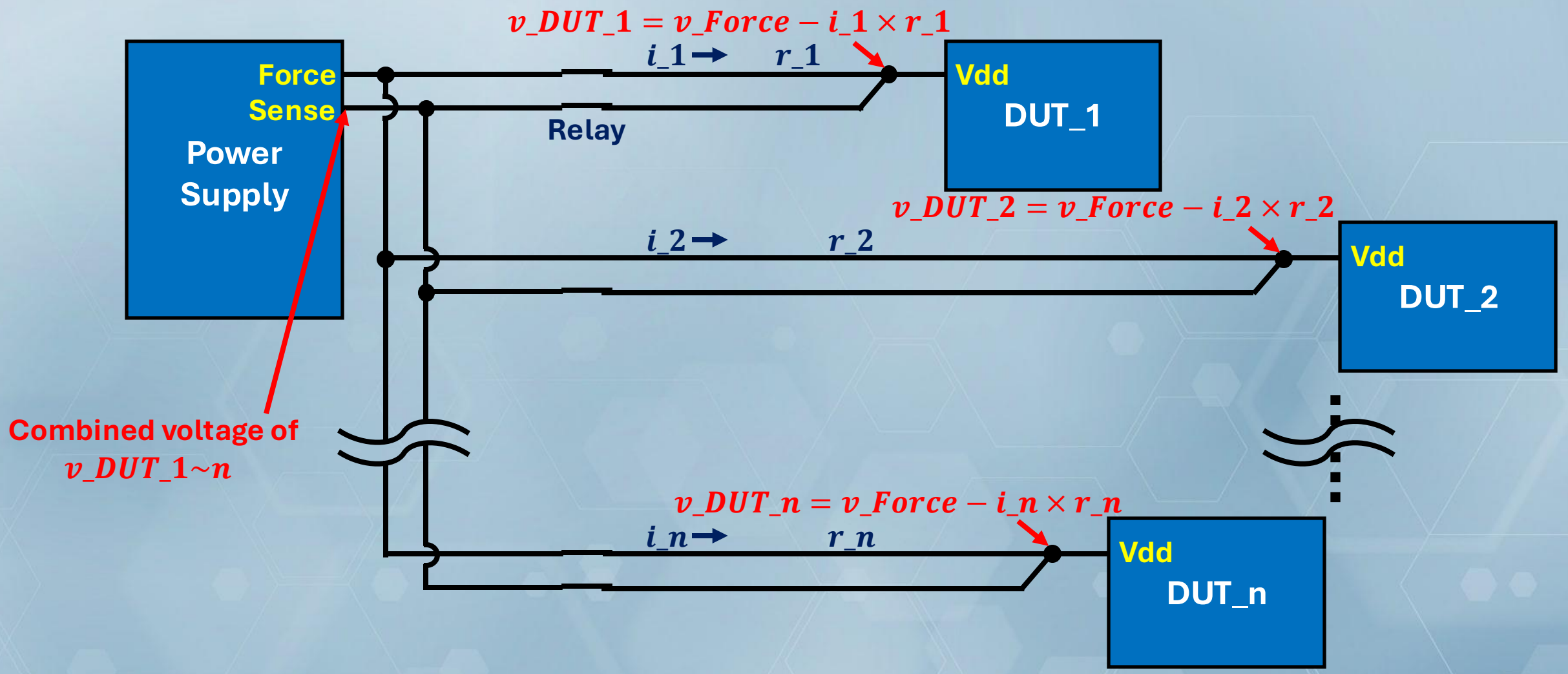
What is the difficulty of the Probe Card?



Cannot pick up ideal share group always due to die layout

The Case of Unequal Distance



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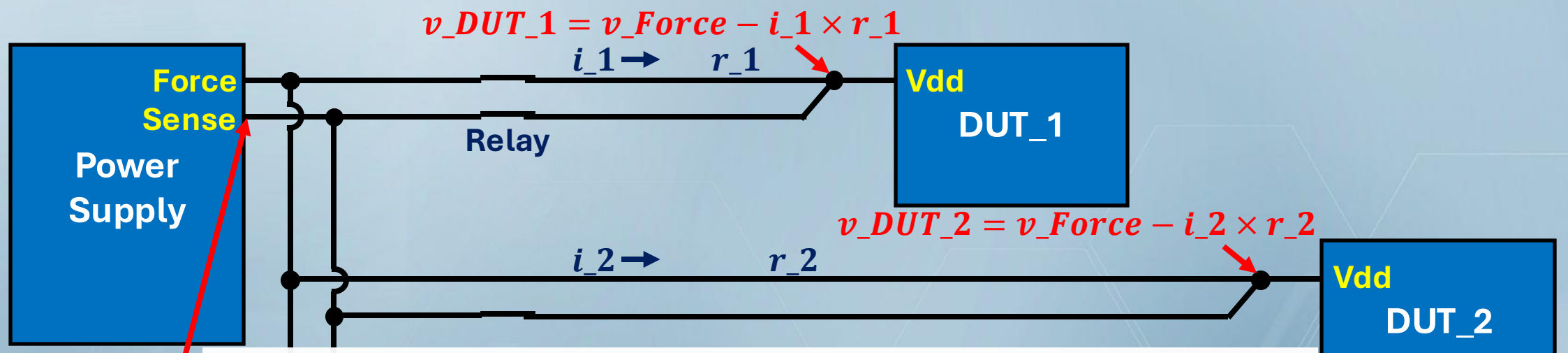
What if trace resistance is not considered?



Combined voltage of $v\_DUT\_1 \sim n$

If r_2 becomes higher than r_1 by longer trace length and i_1 equals to i_2,
v_DUT_2 becomes lower than v_DUT_1.

$$*v\_DUT\_2 - v\_DUT\_1$$
$$= (v\_Force - i\_2 \times r\_2) - (v\_Force - i\_1 \times r\_1)$$
$$= i \times (r\_1 - r\_2) < 0$$
$$\Rightarrow v\_DUT\_2 < v\_DUT\_1$$

How is the impact on the test?

- **Estimate with realistic condition**

	Target voltage	Current consumption	Trace resistance	IR drop	Voltage each DUT	Combined sense voltage	Compensated Force voltage	Final Voltage at DUT
DUT_1	1V	1A	**0.1 ohm**	0.1V	0.9V	0.8V	1.2V	**1.1V**
DUT_2			**0.3 ohm**	0.3V	0.7V			**0.9V**

***This estimation ignores the variation of current consumption by changing of force voltage.**

Can this gap be acceptable??

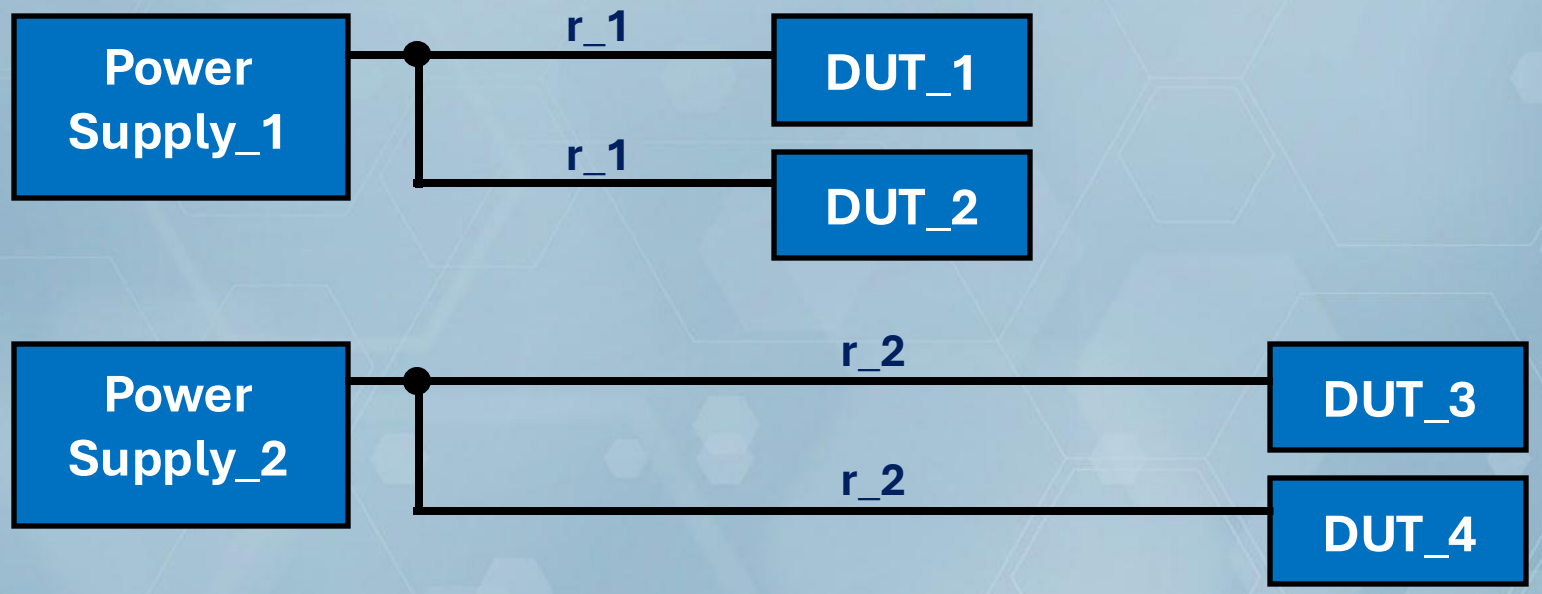
What will be the solution?

- Define the design rule to minimize the variation of the trace resistance within the same shared group.
- To meet this rule, tester resource assignment must be optimized to minimize the distance to DUT.
- If it cannot, use wider or multiple trace line to reduce the resistance.
- Undesired option is to increase the resistance on small resistance line.

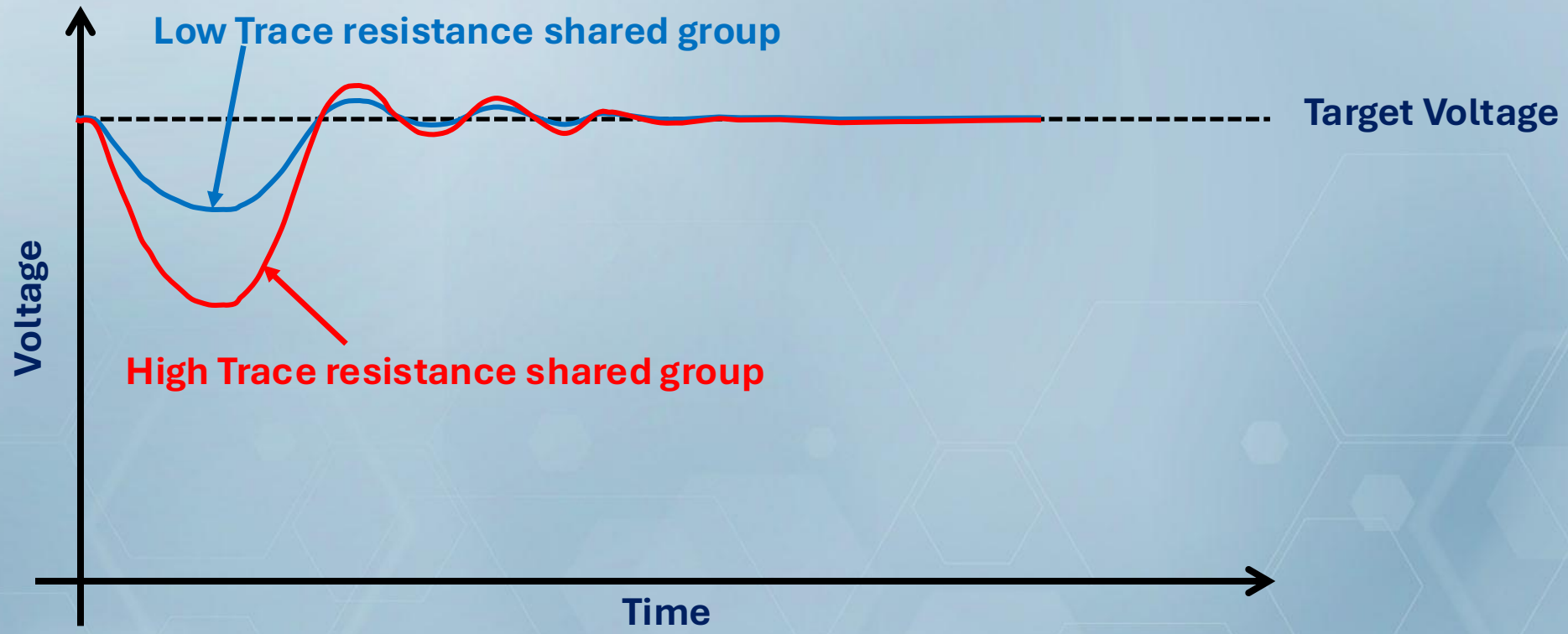
Acceptable condition

- It is acceptable to have the variation between different shared groups, but it is better to make the resistance uniform for the whole probe card.

e.g.



Transient of IR drop



If enough wait time is not inserted, this voltage gap has effects on the test condition.
Adding wait time is one solution but could increase test time.
So, uniformizing the trace resistance is better.

Uncontrollable Factor

- **What if the current consumption is different each DUT?**

	Target voltage	Current consumption	Trace resistance	IR drop	Voltage each DUT	Combined sense voltage	Compensated Force voltage	Final Voltage at DUT
DUT_1	1V	**1.0A**	0.2 ohm	0.2V	0.8V	0.75V	1.25V	**1.05V**
DUT_2		**1.5A**		0.3V	0.7V			**0.95V**

***This estimation ignores the variation of current consumption by changing of force voltage.**

It makes the difference of the voltage at DUT.
We also need to consider this gap in the test condition.
Of course, decreasing trace resistance can mitigate the impact.

Ask of Probe Card Industry

- **Develop the new technology to control trace resistance as follows.**
  - **Further multi-layers**
  - **Low resistance trace material**

Summary

- Trace resistance is an important factor affecting test condition, but it is manageable if we know the mechanism.
- On the other hand, there are other factors. We must know those effects and manage test criteria.