Computer Hardware
&
Industry Perspective

커리큘럼

주차	날짜	이론	실습	선각 보고서 주제
1주차	4/20 (일)	오리엔테이션, 하드웨어 구성 요소 개요	데스크탑 전체 분해, 주요 부품 구조 관찰	컴퓨터를 이해한다는 건 무엇일까?
2주차	4/26 (토)	메모리 & 저장장치 구조	RAM 분리/장착, SSD 분해 관찰	저장 장치는 결국 사라질까?
3주차	5/3 (토)	발열과 냉각 구조	CPU 쿨러 제거 + 써멀 재도포, 팬 속도 측정	열 관리가 성능을 결정한다면 우리는 어떻게 설계해야 할까?
4주차	5/17 (토)	CPU 구조 & 최신 기술 + 분해 실습	CPU 히트스프레더 제거	CPU의 성능 향상이 둔화된 이유와 기술적 대안
5주차	5/24 (토)	GPU 구조 & 최신 기술	GPU 분해, 관찰, 레이트레이싱과 DLSS 체험	AI는 GPU 없이 존재할 수 있는가?
6주차	미정	입출력 장치 & HCI	키보드/마우스 분해 및 센서 원리 학습	사람과 기계의 경계는 어디까지 사라질 수 있을까?
7주차	미정	반도체 제작: 웨이퍼~패키징 전체 흐름	공정 흐름도 도식화, 칩 구조 스케치, 패키지 비교	성능은 결국 패키징으로 결정되는가?
8주차	미정	미래 컴퓨팅 구조 - 포스트 폰 노이만 등	아키텍처 비교, 미래 예측	우리는 어떤 컴퓨팅 구조 위에서 살아가게 될까?

22:00

1교시 : 과제 발표

쉬는 시간 10분

2교시 : 이론

쉬는 시간 10분

3교시 : 실습

01:00?

이론

게임은 왜 CPU가 아닌 GPU로 돌리는 걸까?

CPU도 연산하는데, 뭐가 다르지?

C.H.I.P

CPU vs GPU의 사고방식

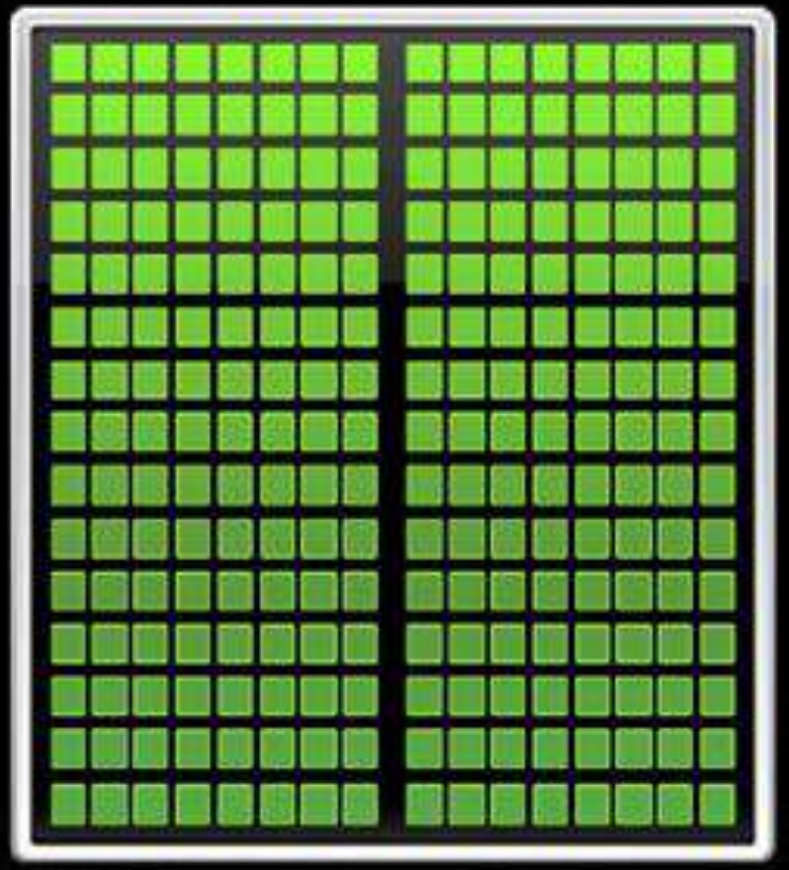
- CPU: 논리적 판단이 빠름 (if문 처리)
- GPU: 수많은 반복 연산을 동시에 빠르게 (그림자, 조명, 텍스처 처리)

CPU

Optimized for Serial Tasks

GPU

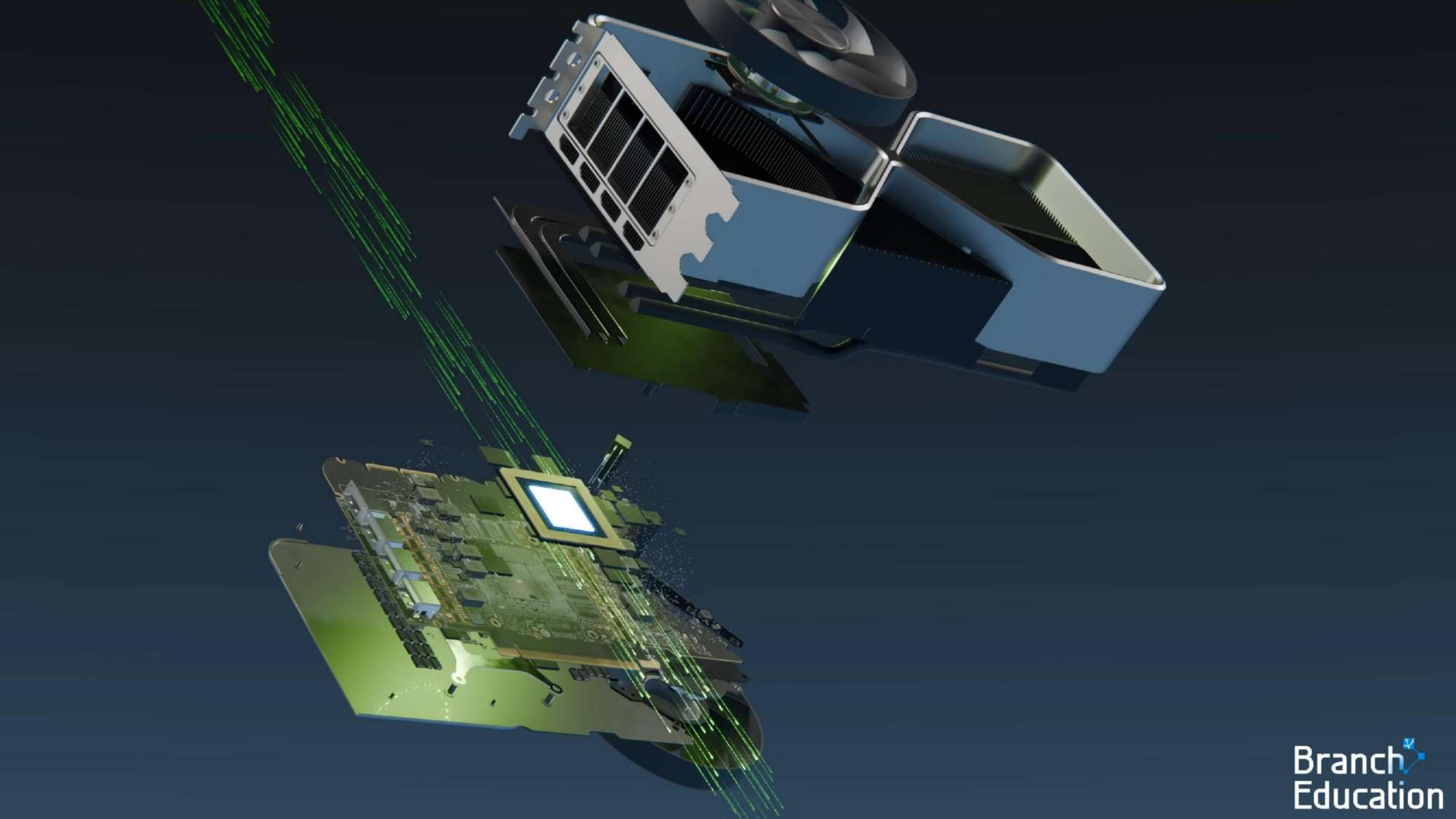
Optimized for Many Parallel Tasks

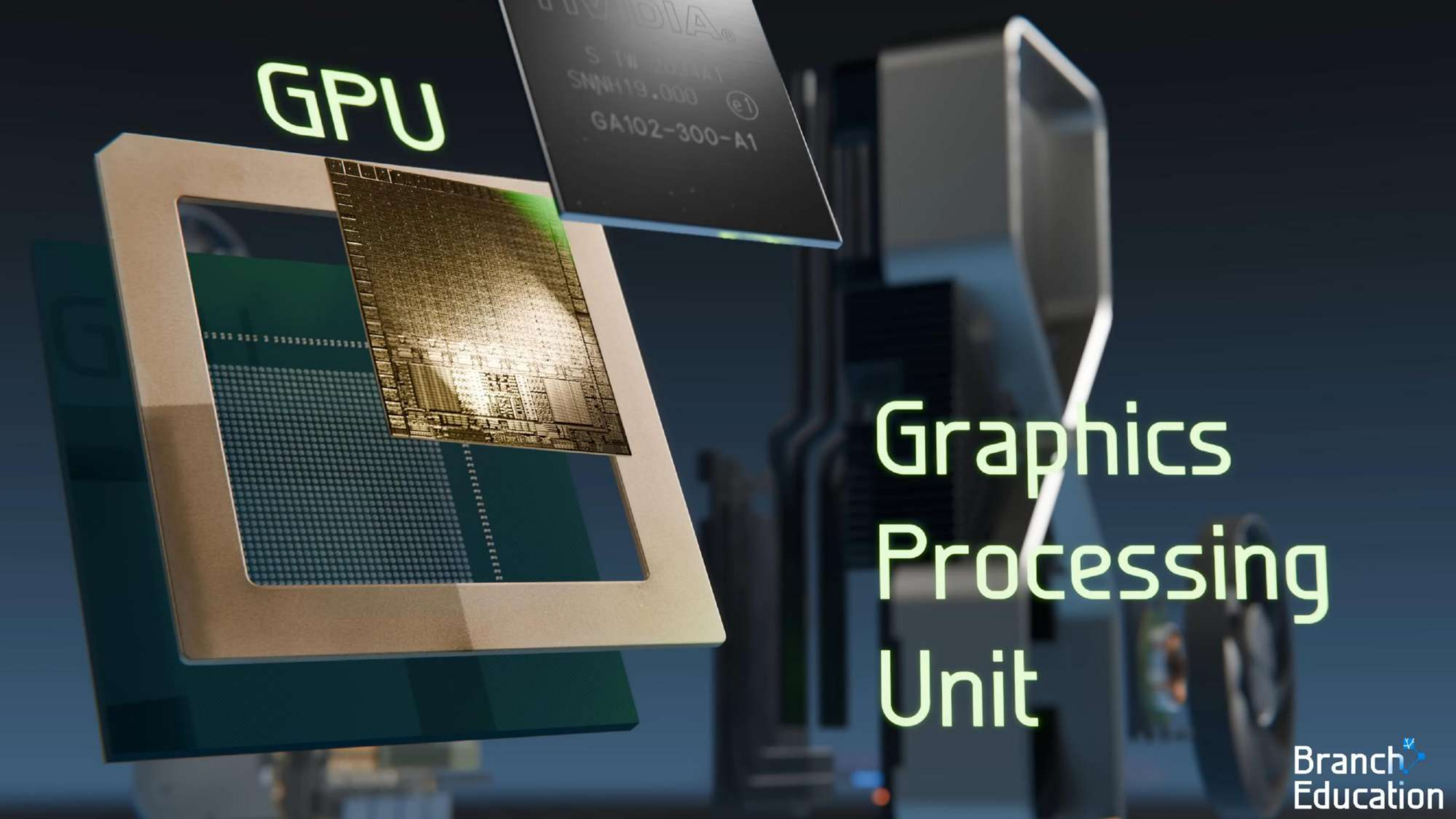


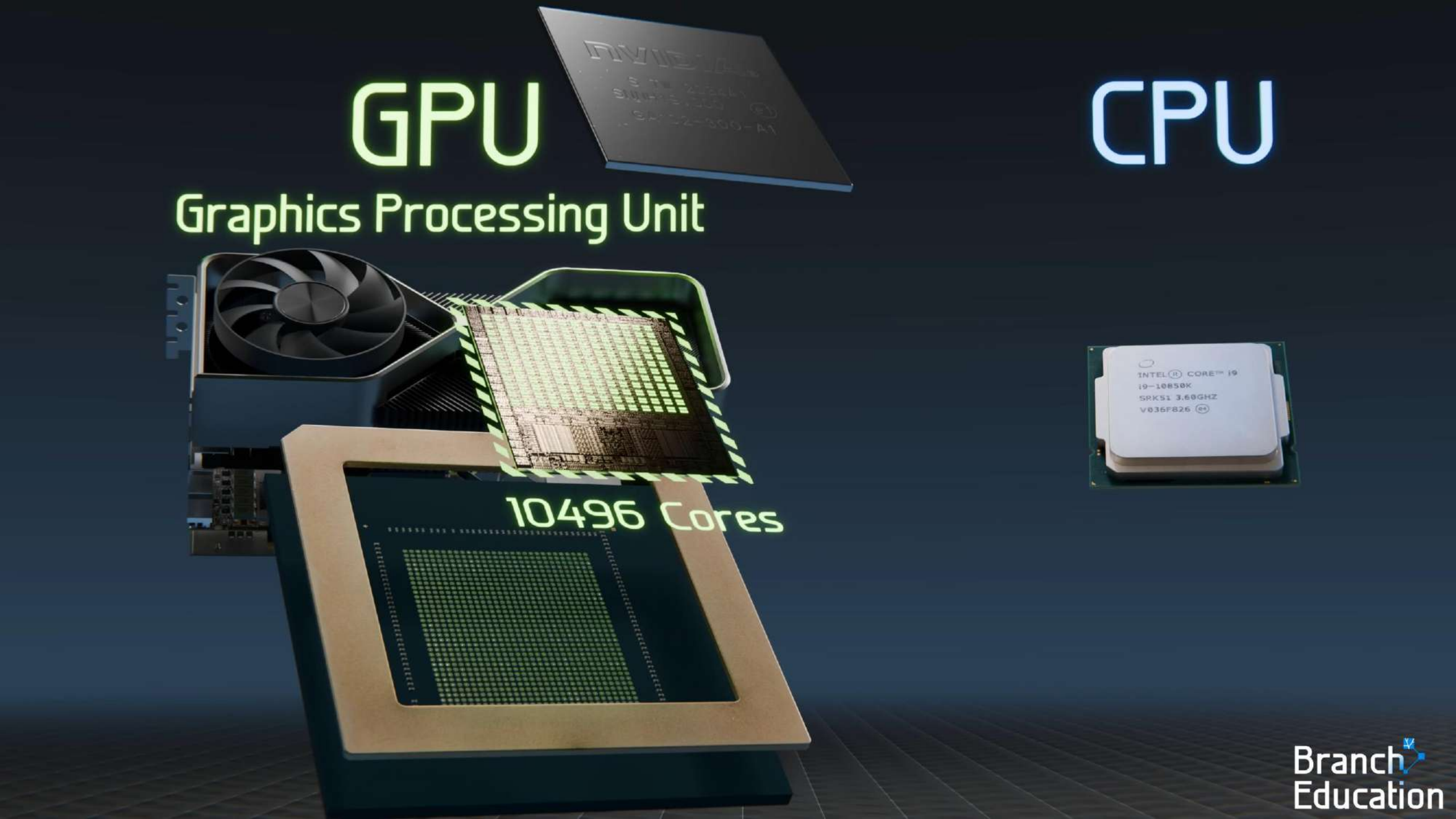
GPU

CPU

Branch Education


Branch
Education


GPU
GA102-300-A1
Graphics
Processing
Unit
Branch
Education

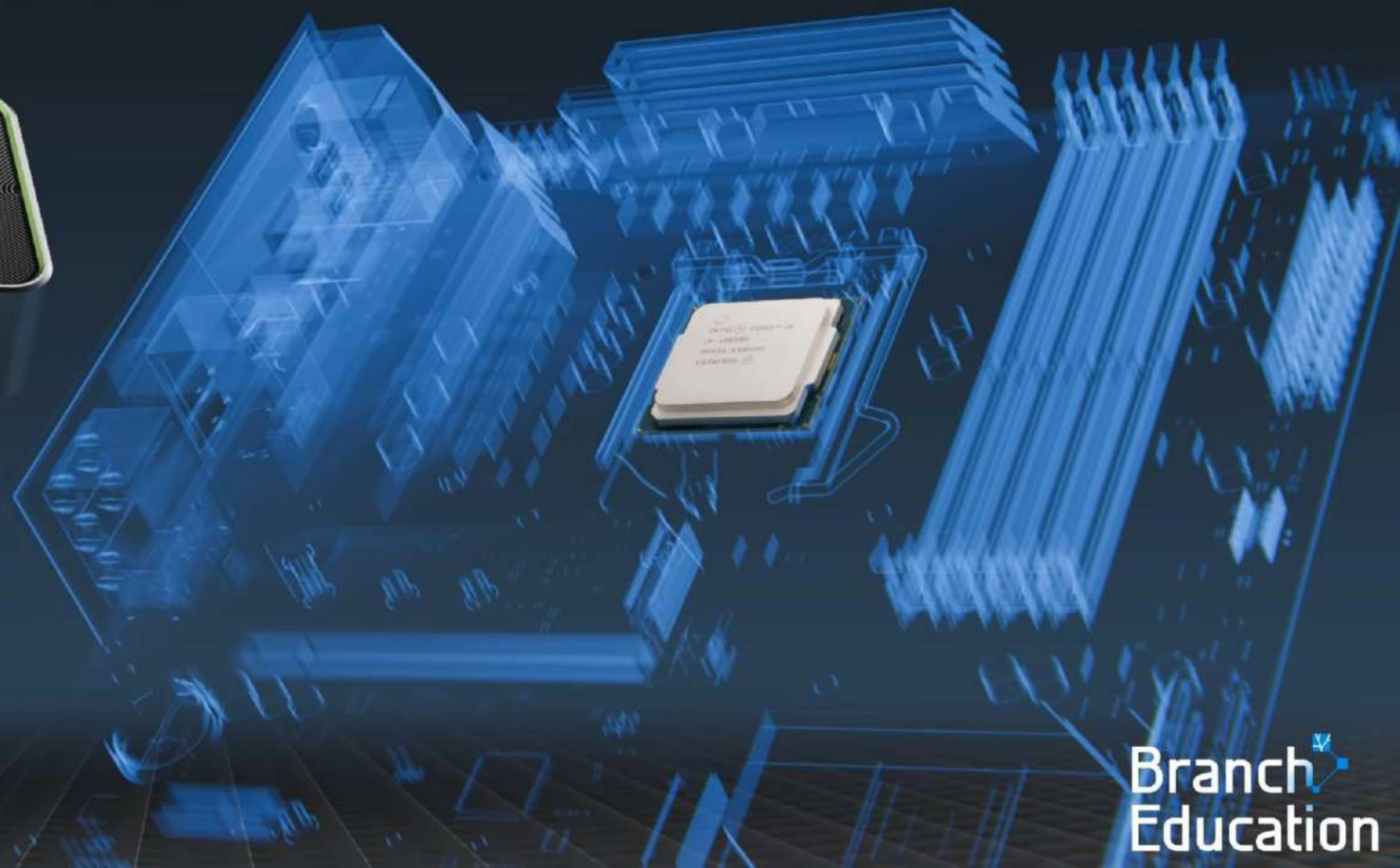

GPU
Graphics Processing Unit
10496 Cores
CPU
INTEL® CORE™ i9
i9-10850K
SRKS1 3.60GHZ
V036F826
Branch
Education

GPU

Graphics Processing Unit

CPU

Central Processing Unit



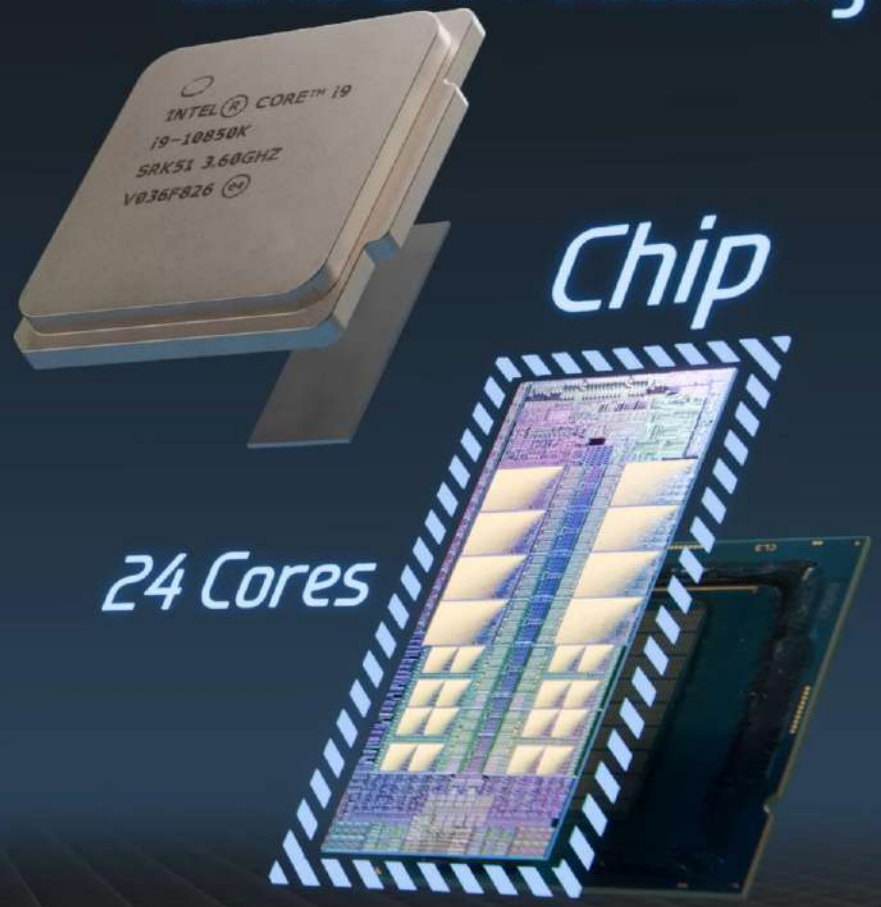
Branch Education

GPU

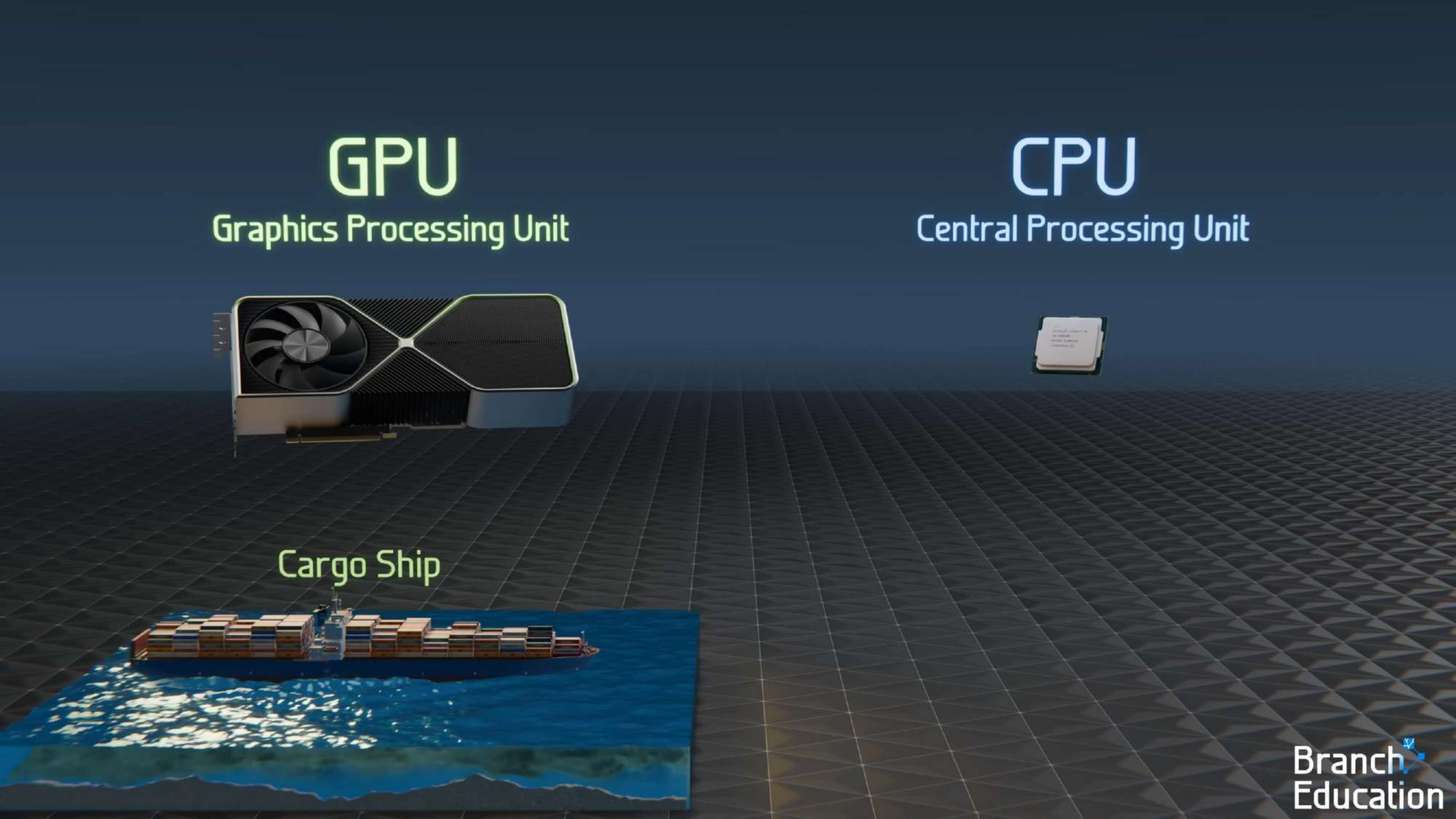
Graphics Processing Unit

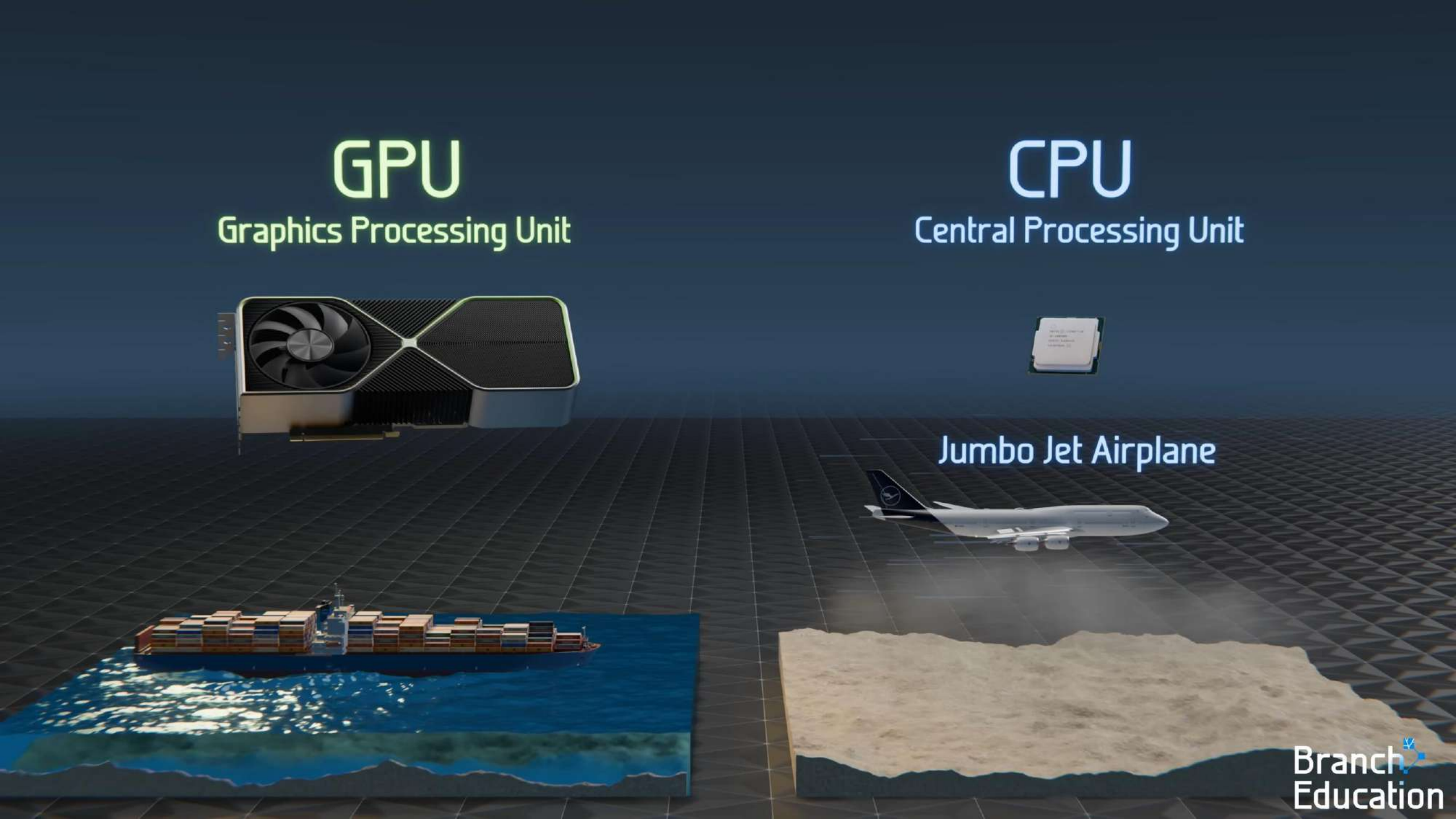
CPU

Central Processing Unit



Branch Education


GPU
Graphics Processing Unit
CPU
Central Processing Unit
Cargo Ship
Branch Education


GPU
Graphics Processing Unit
CPU
Central Processing Unit
Jumbo Jet Airplane
Branch Education

CPU

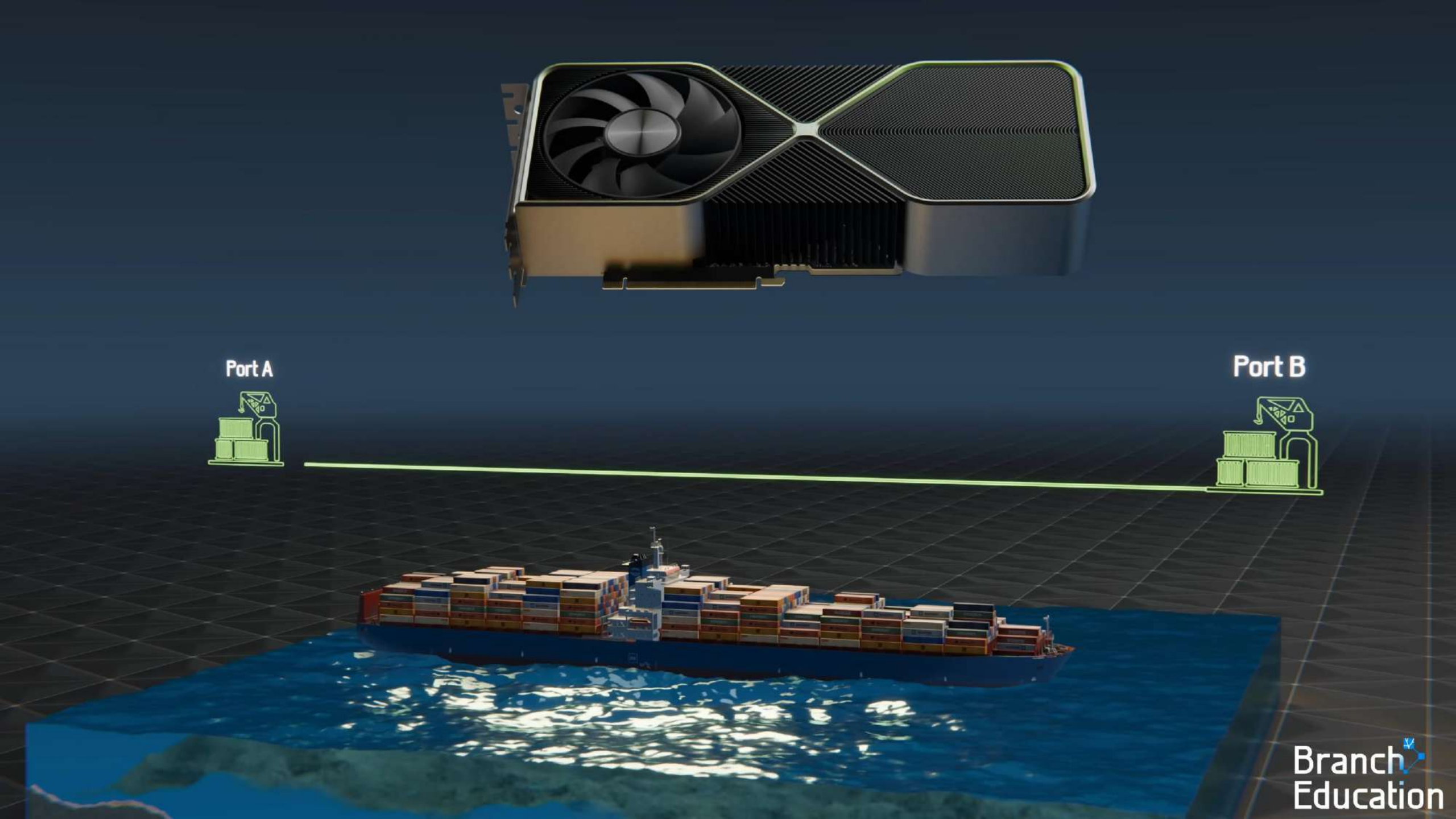
Central Processing Unit

Branch Education

CPU

Central Processing Unit

Branch Education

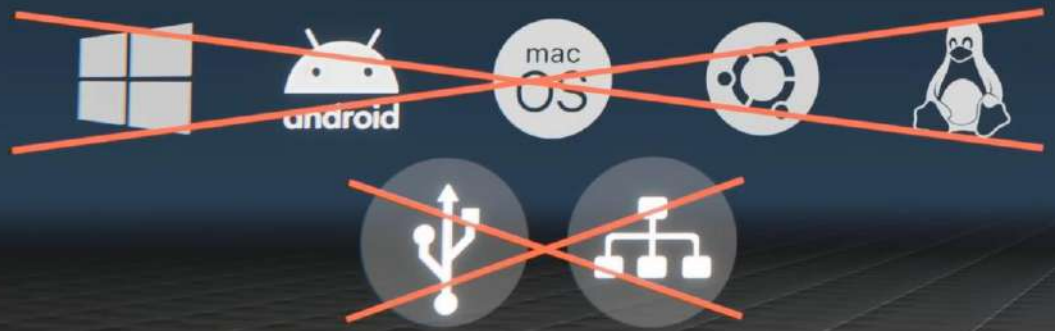

Port A
Port B
Branch
Education

GPU
Graphics Processing Unit

CPU
Central Processing Unit

Branch Education

GPU
Graphics Processing Unit



CPU
Central Processing Unit

Branch Education

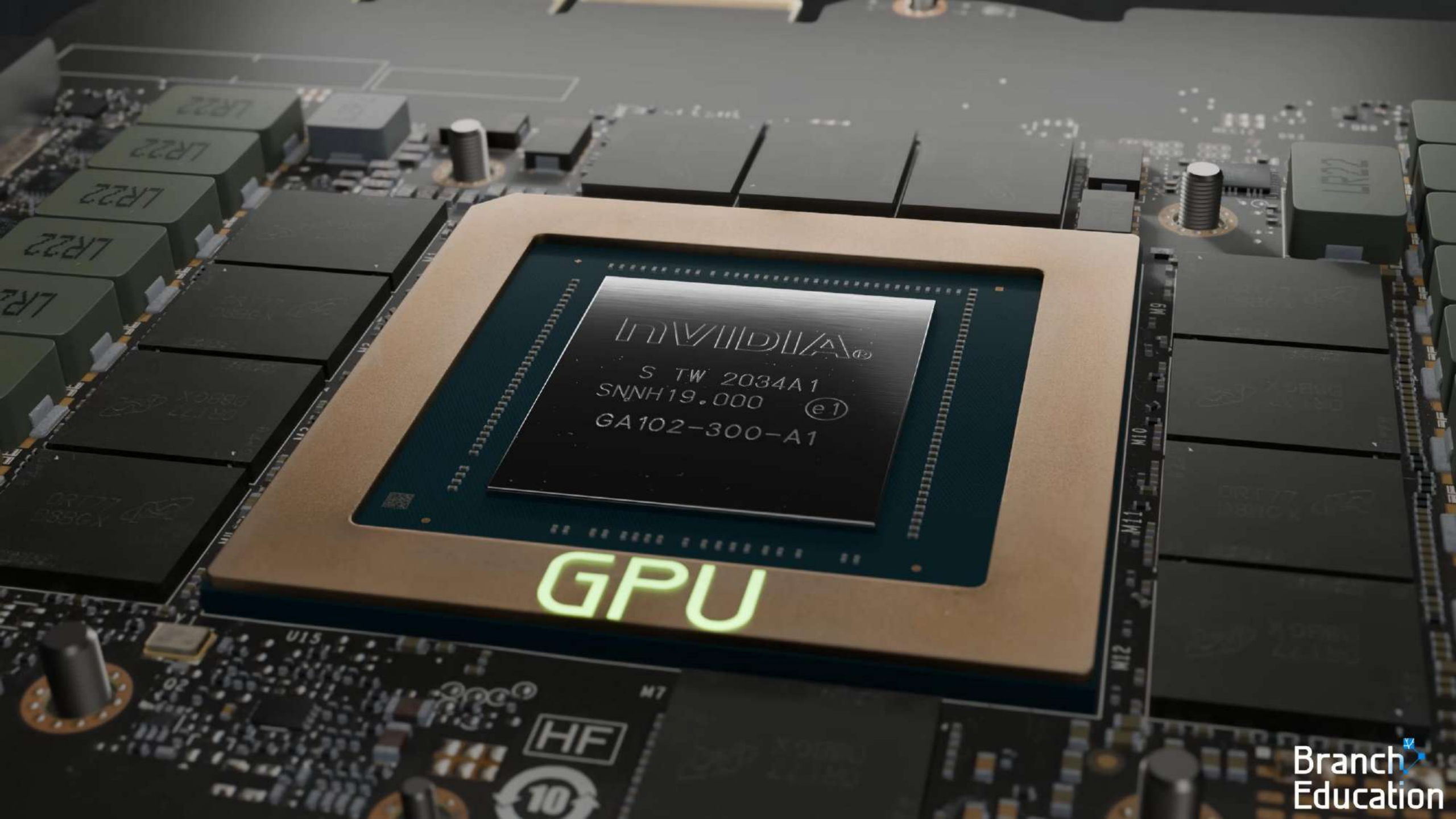
그래픽카드 안엔 뭐가 들었을까?

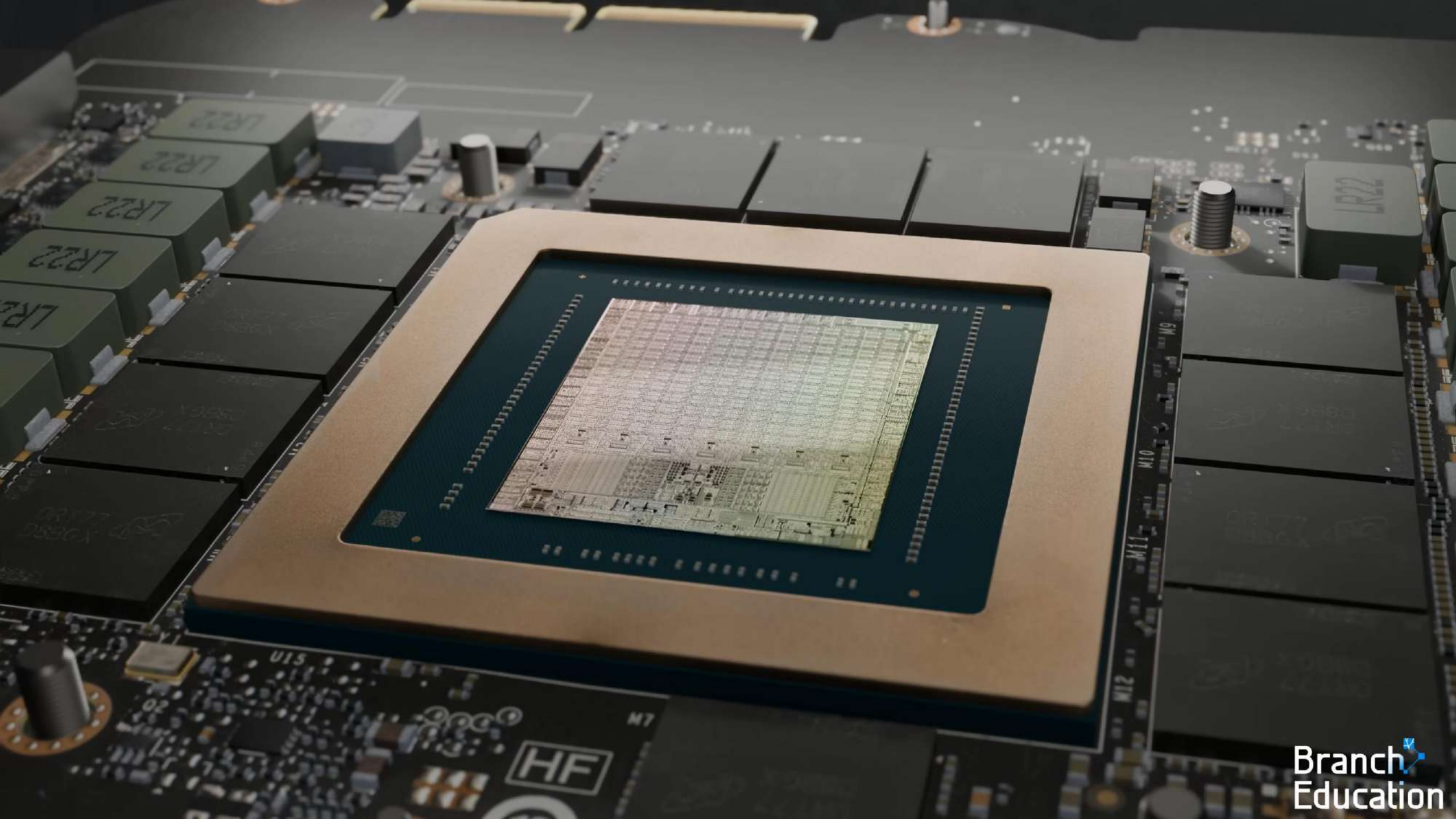
분해 전에 알아야 할 해부학

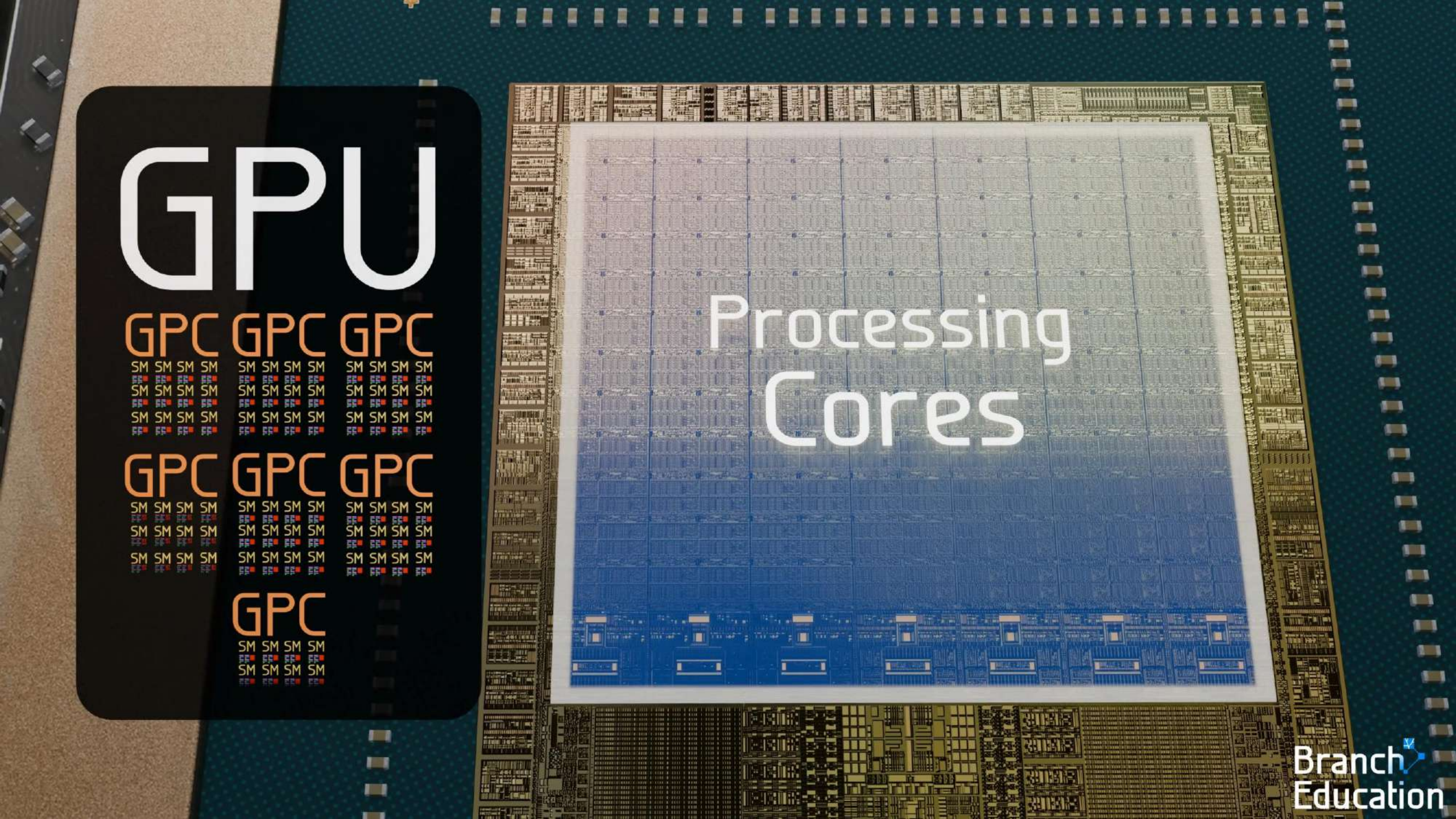
C.H.I.P

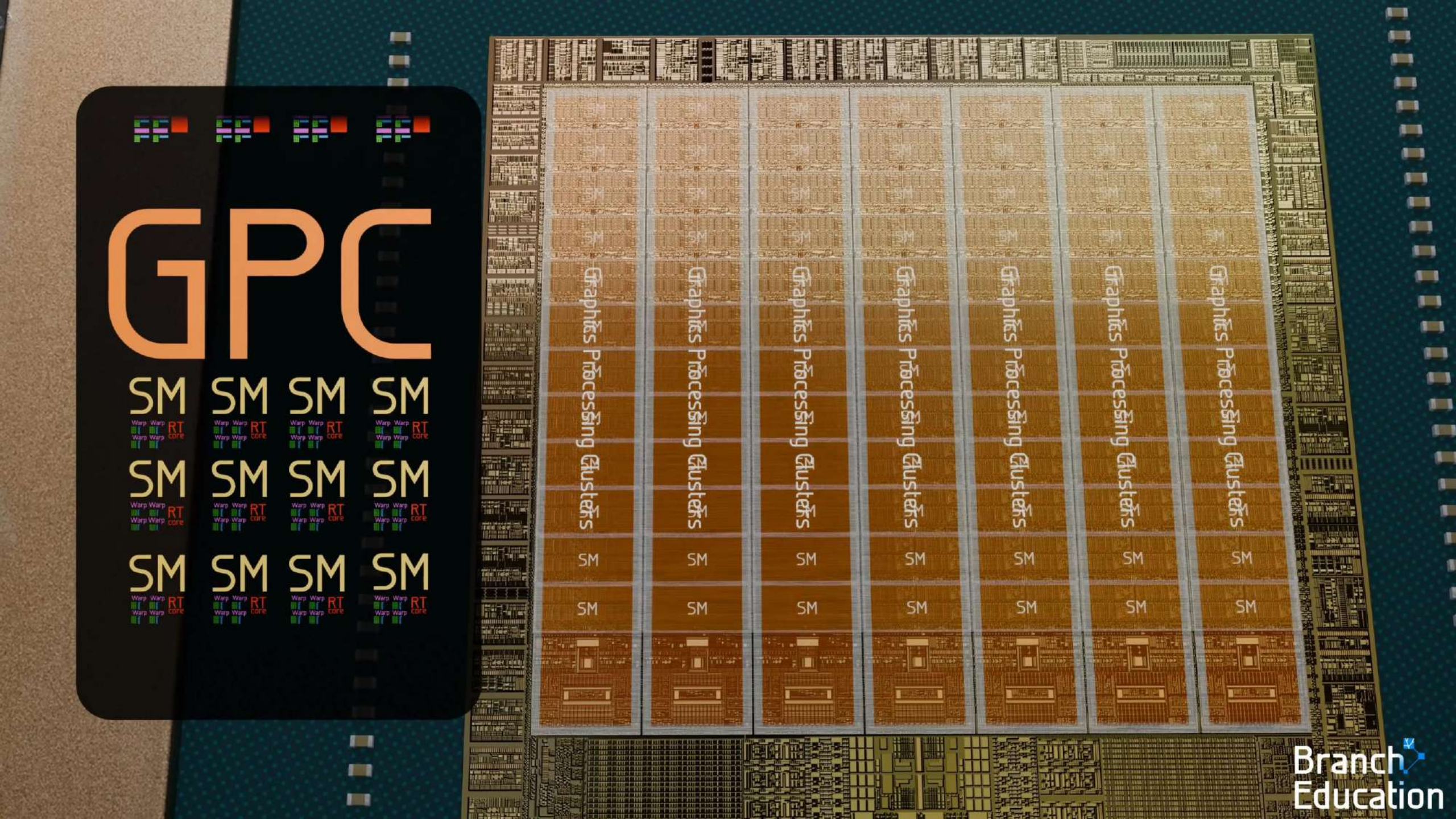
GPU 다이 (실제 연산의 심장)

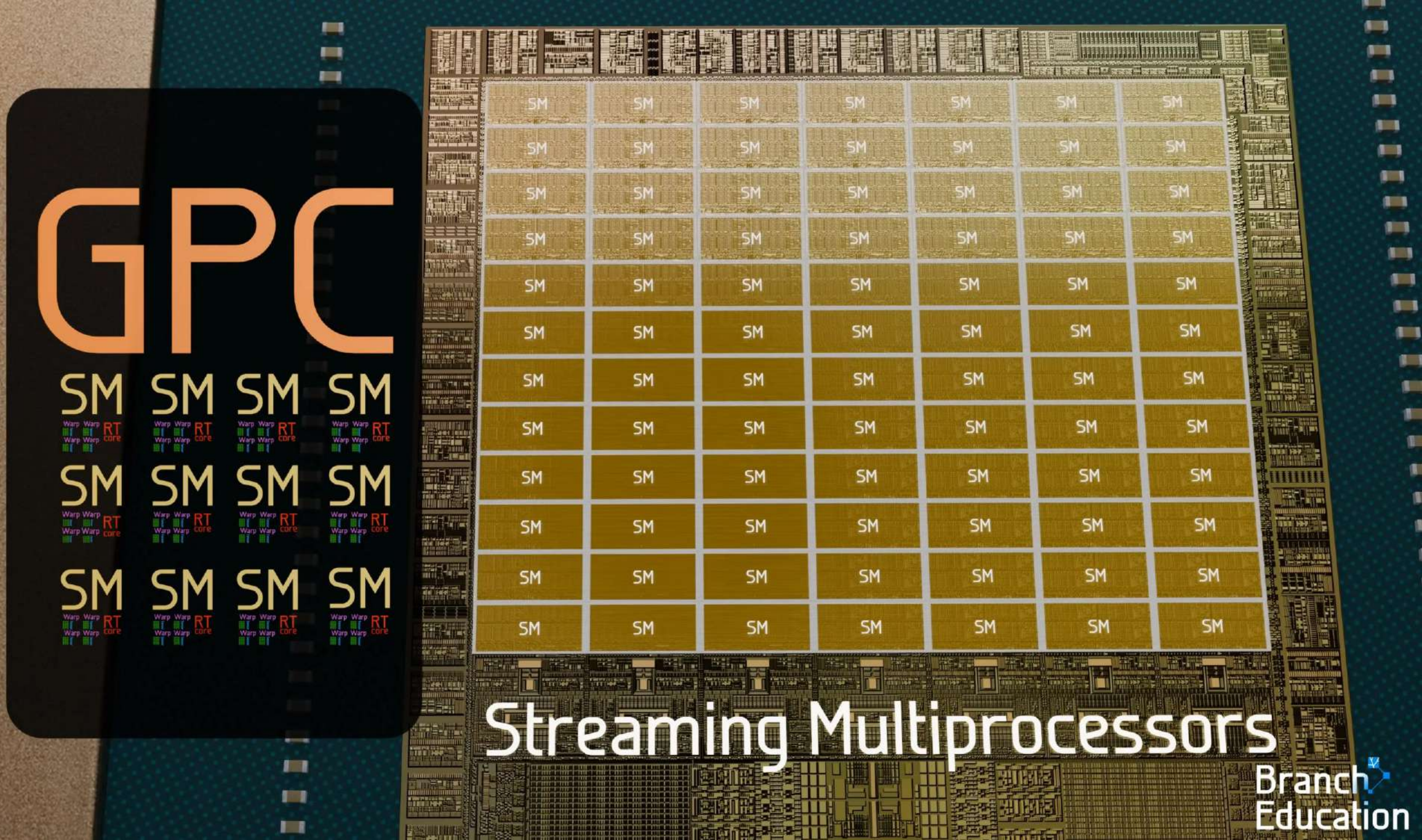
- CUDA 코어 수천 개 내장
- RTX 3080 Ti 기준 약 10240개,
- A100은 무려 69120개!

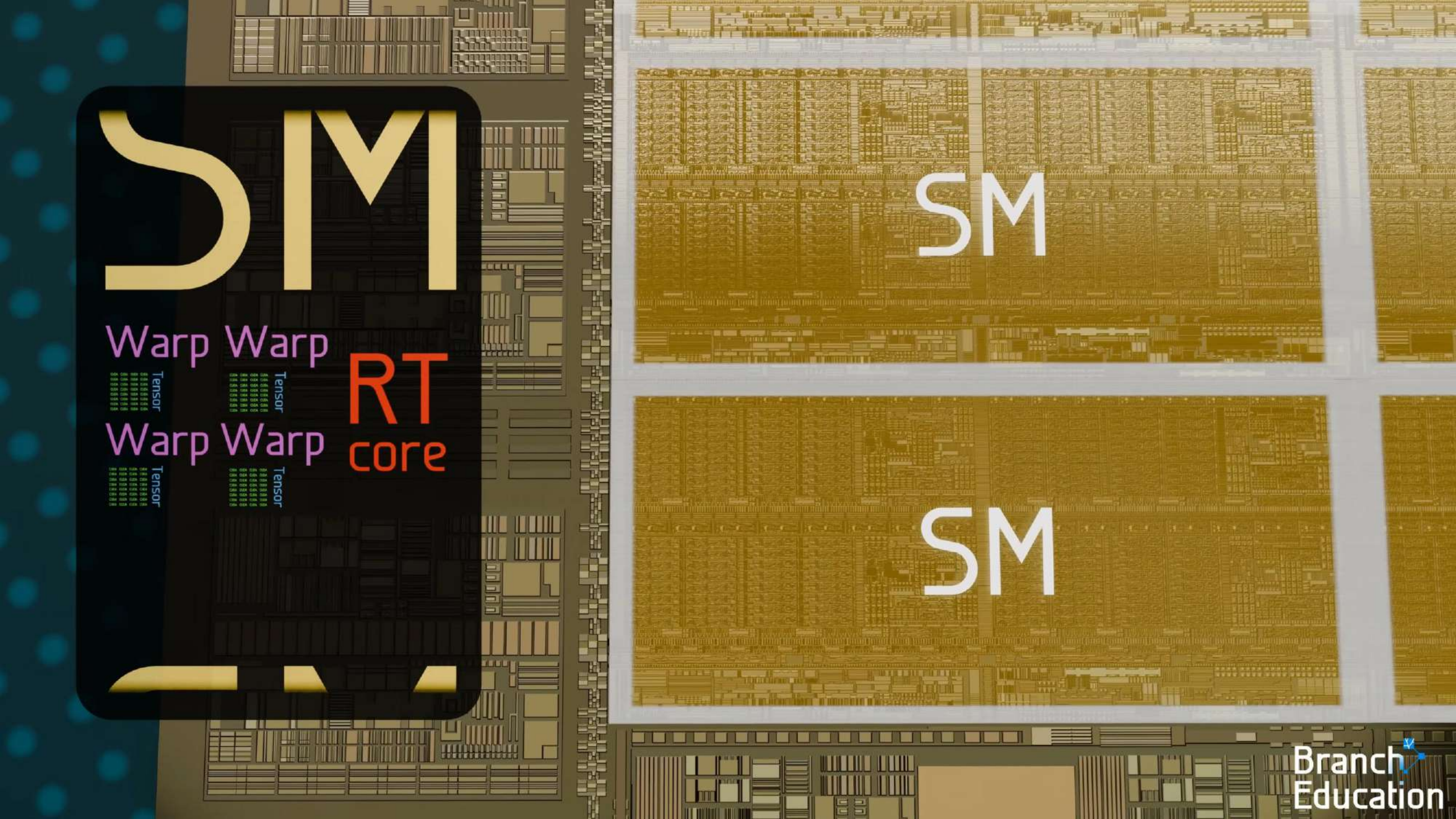

NVIDIA
S TW 2034A1
SNNH19.000
GA102-300-A1
GPU
HF
Branch
Education

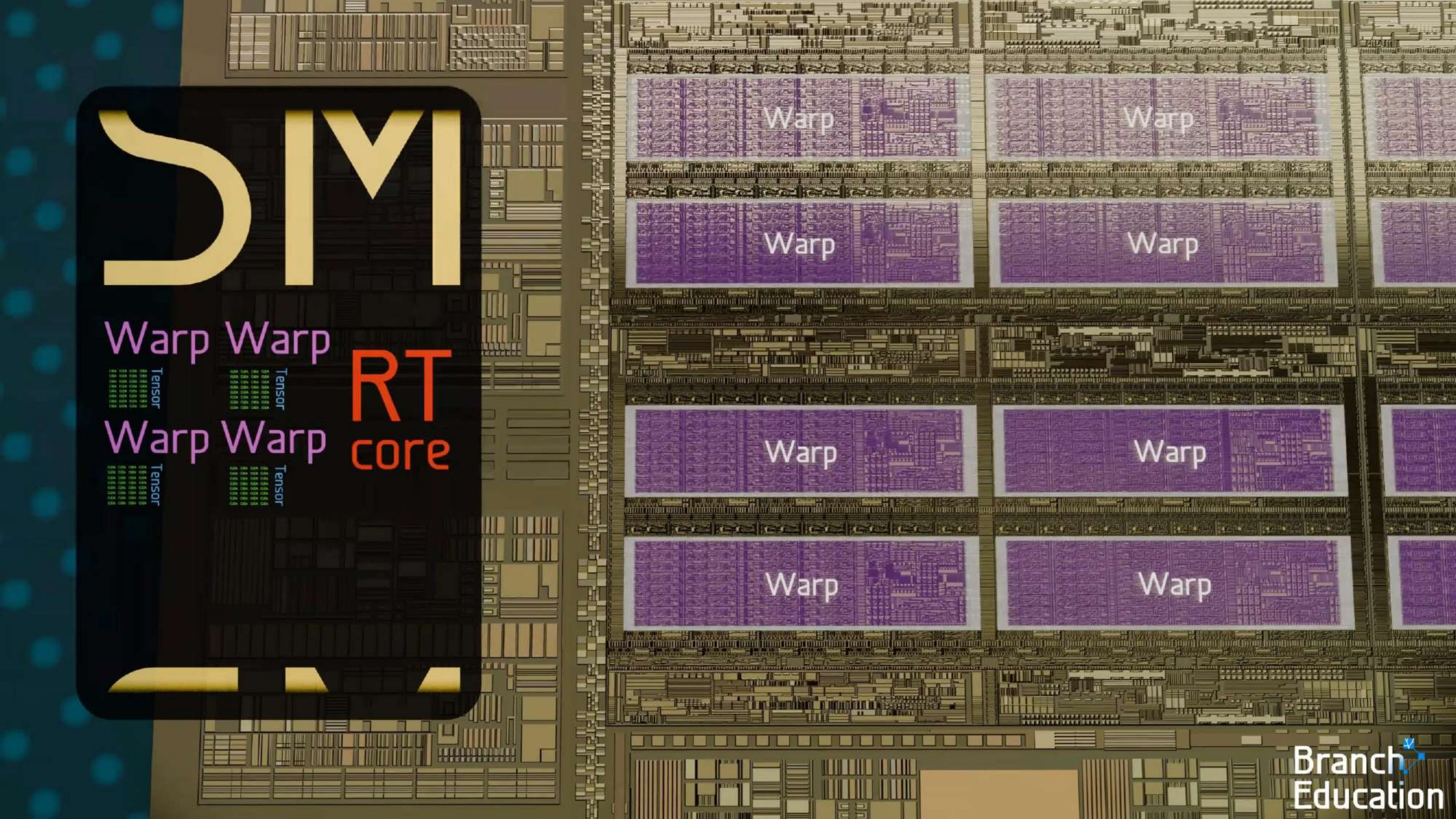

LR22
HF
Branch
Education

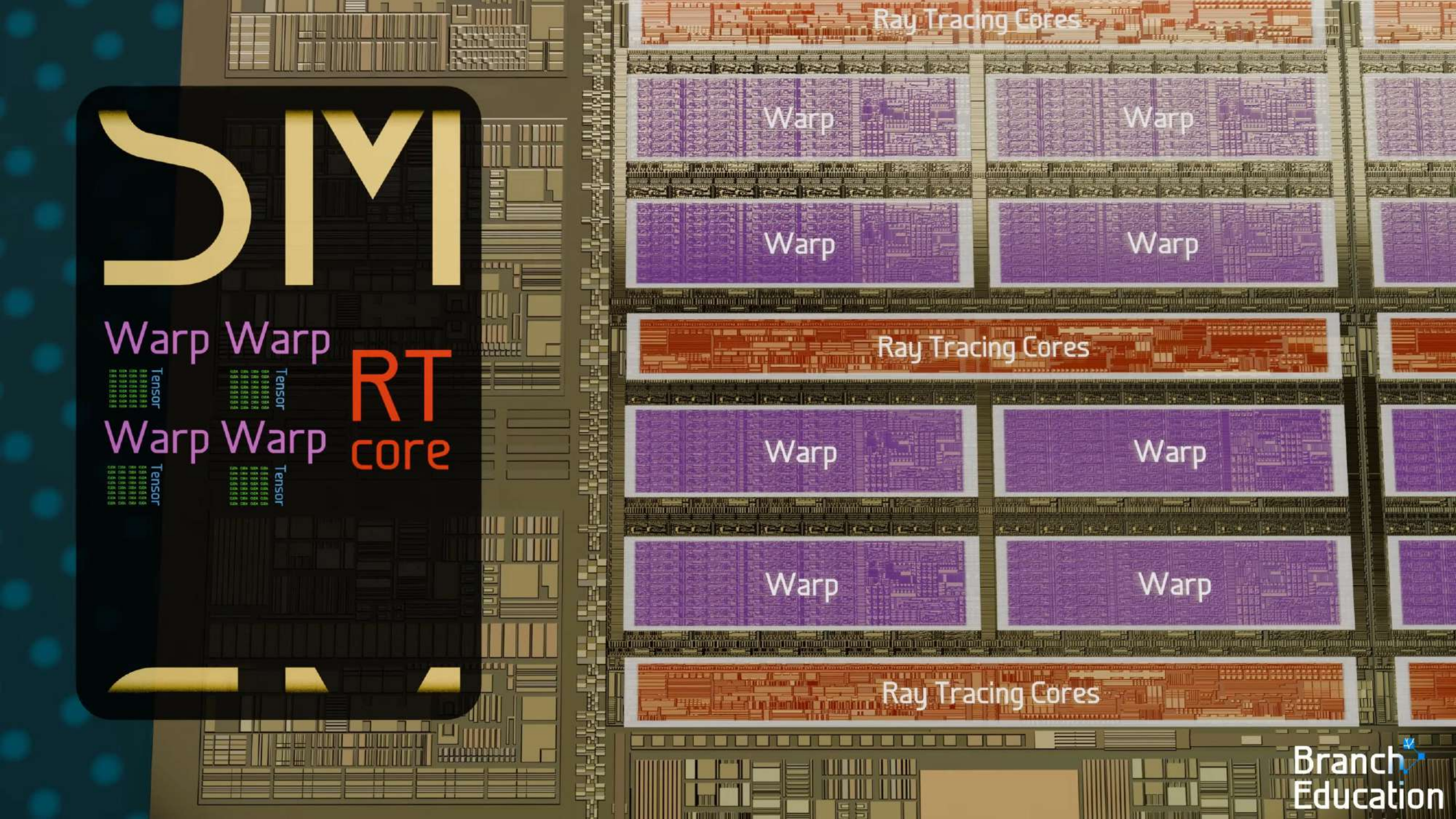

GPU
GPC GPC GPC
GPC GPC GPC
GPC
SM
Processing
Cores
Branch
Education

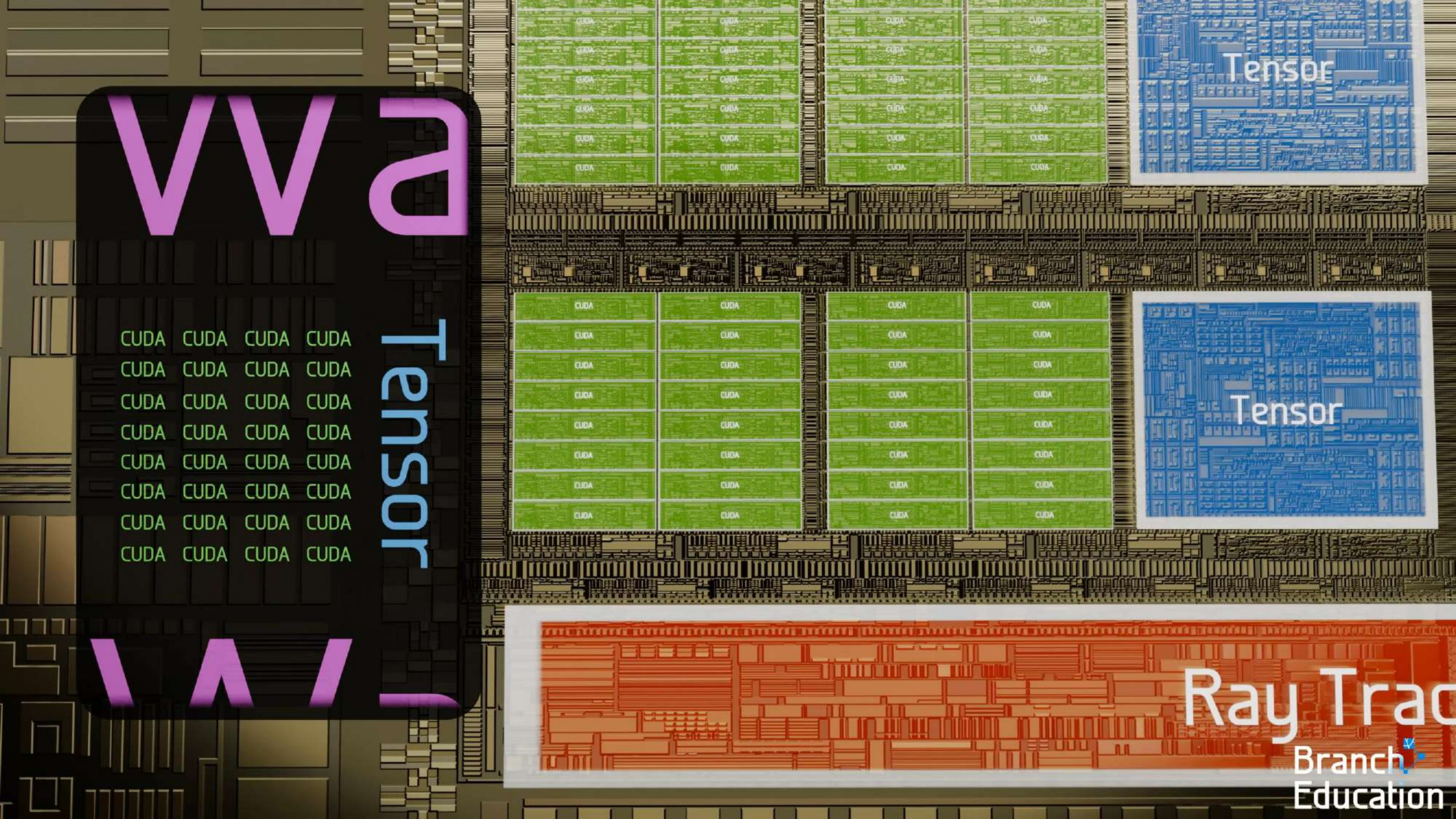

GPC
SM
Warp
RT core
Graphics Processing Clusters
Branch Education

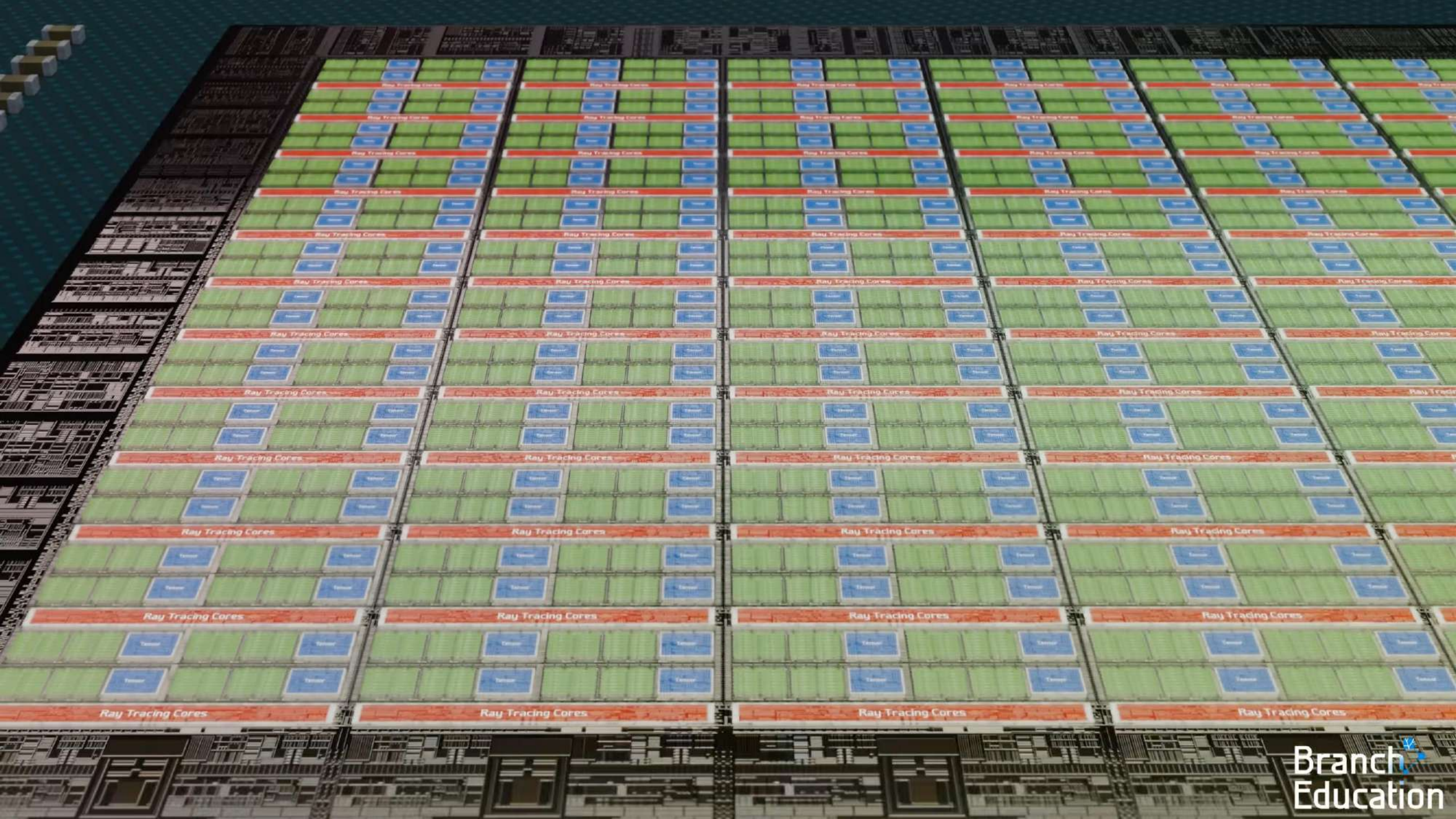

GPC
SM
Warp
RT core
Streaming Multiprocessors
Branch Education


SM
Warp
Warp
Tensor
Tensor
RT
core
Warp
Warp
Tensor
Tensor
SM
SM
Branch
Education

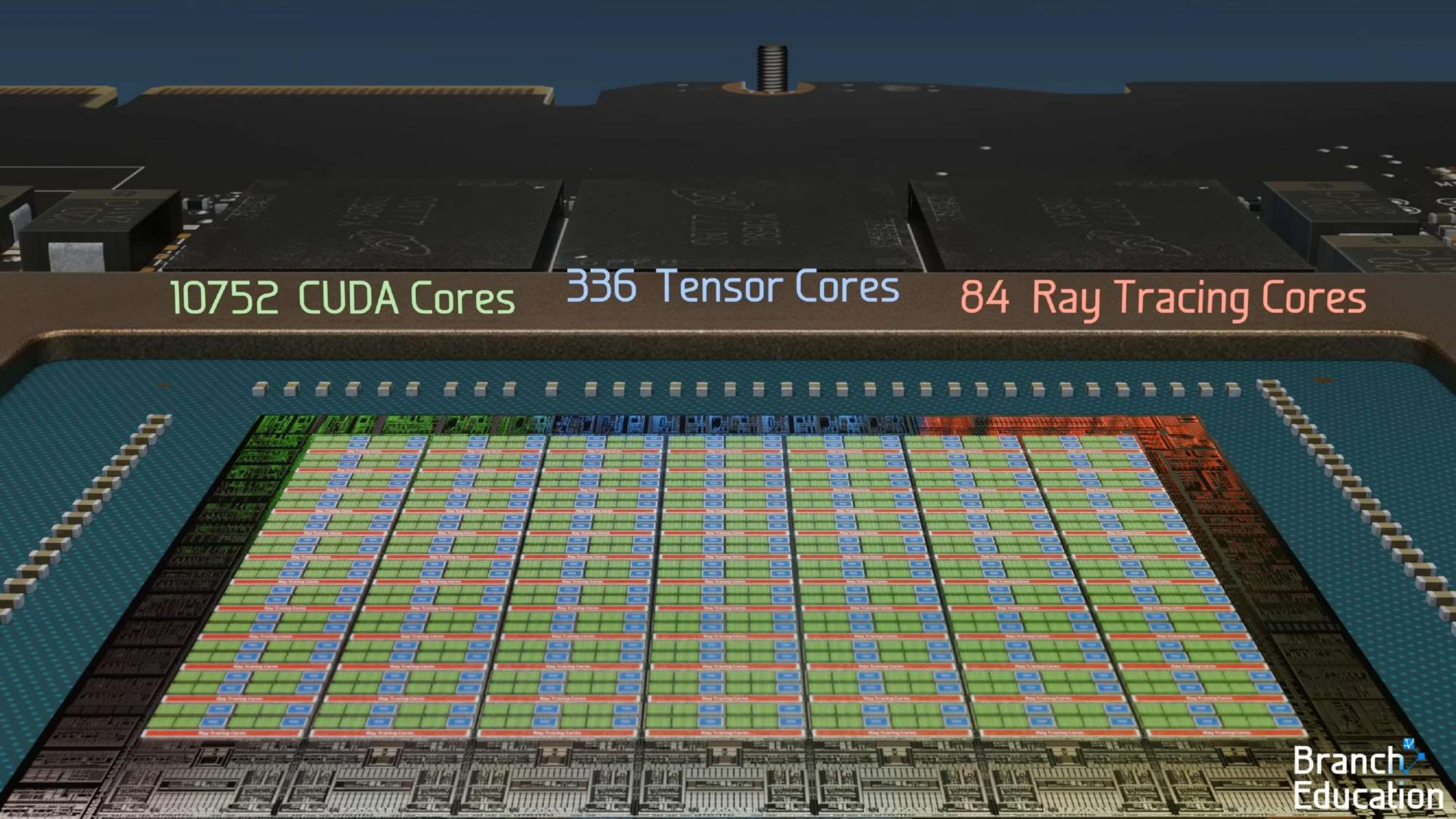

SM
Warp
Warp
Tensor
Tensor
RT
core
Warp
Warp
Tensor
Tensor
Warp
Warp
Warp
Warp
Warp
Warp
Warp
Warp
Branch
Education


SM
Warp
Warp
Tensor
Tensor
RT
core
Warp
Warp
Tensor
Tensor
Ray Tracing Cores
Warp
Warp
Warp
Warp
Ray Tracing Cores
Warp
Warp
Warp
Warp
Ray Tracing Cores
Branch
Education

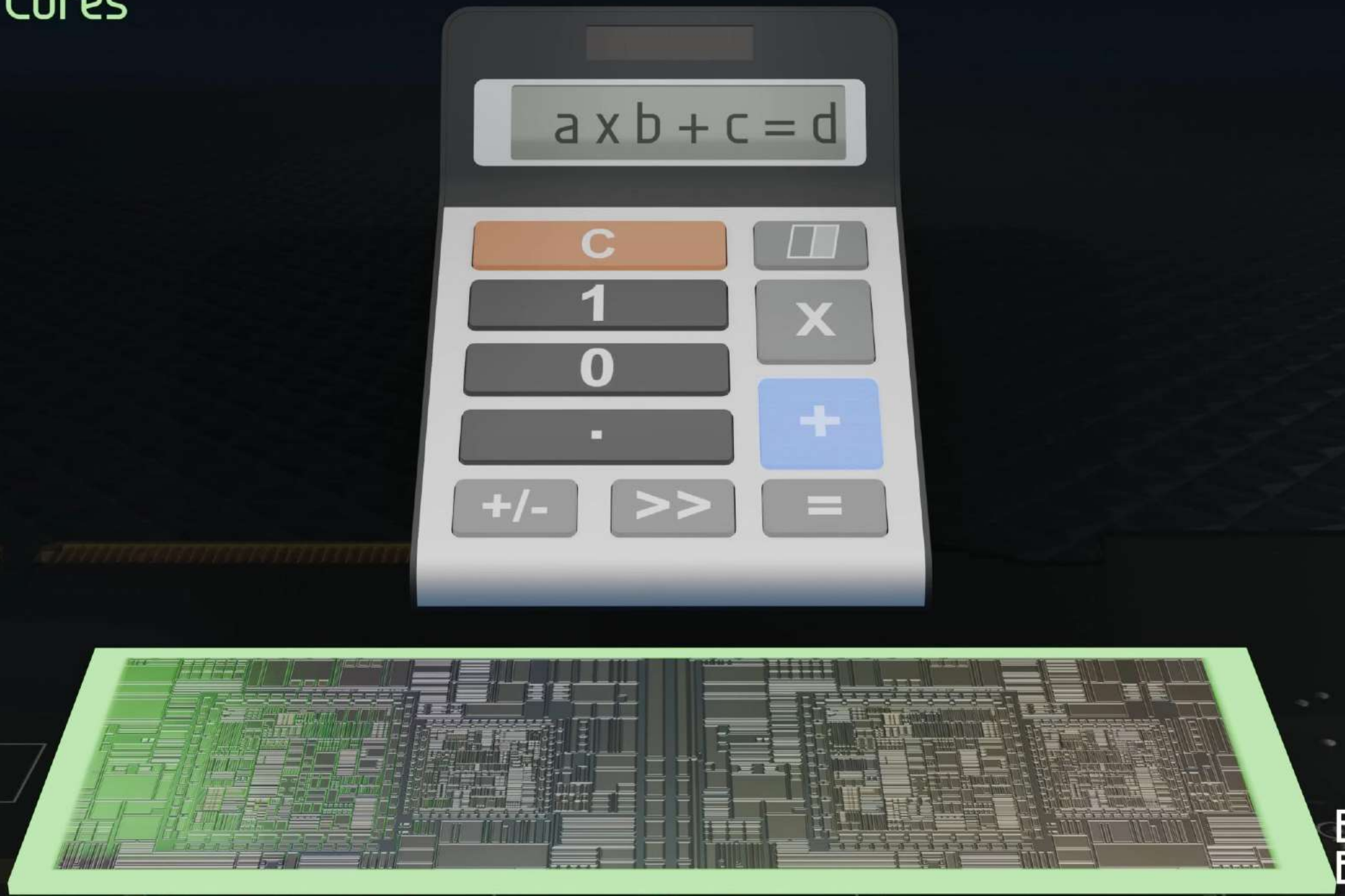

Tensor
Tensor
Tensor
CUDA
Ray Trac
Branch
Education


Ray Tracing Cores
Tensor
Branch Education

10752 CUDA Cores
Branch Education

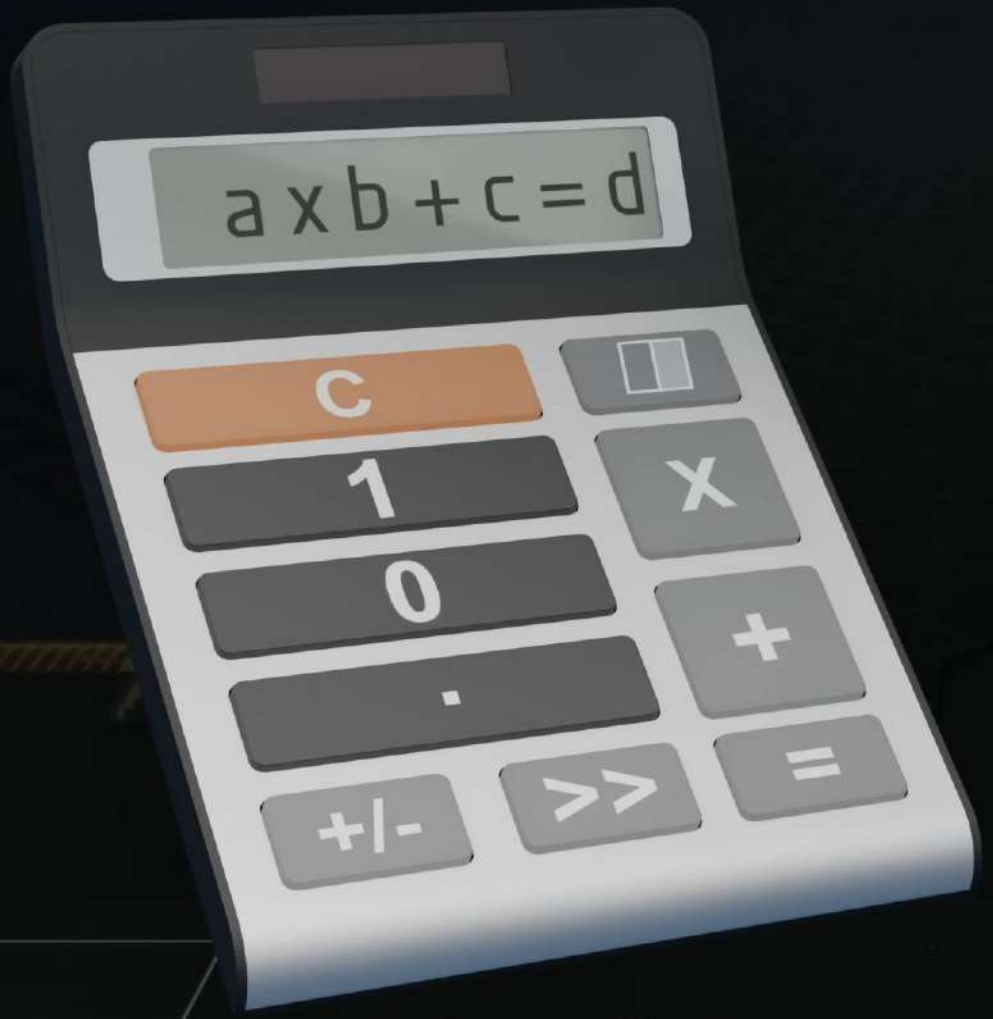

10752 CUDA Cores
336 Tensor Cores
84 Ray Tracing Cores
Branch Education

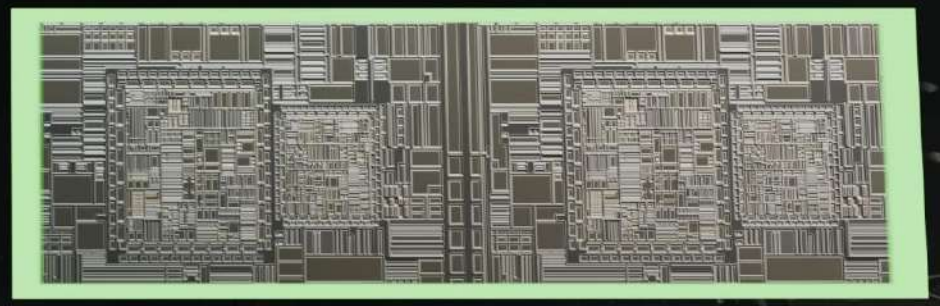
CUDA Cores



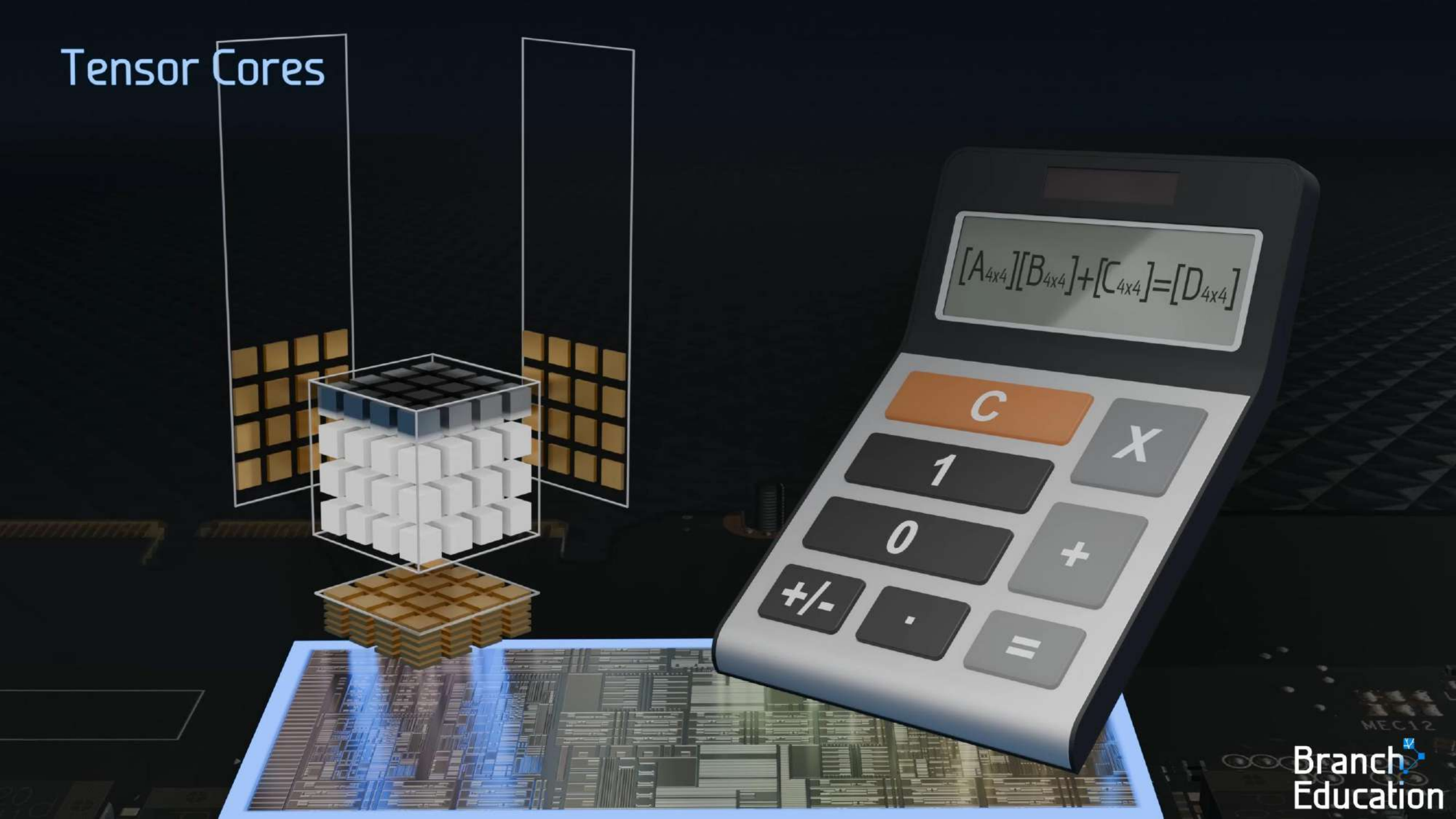
Branch Education

CUDA Cores

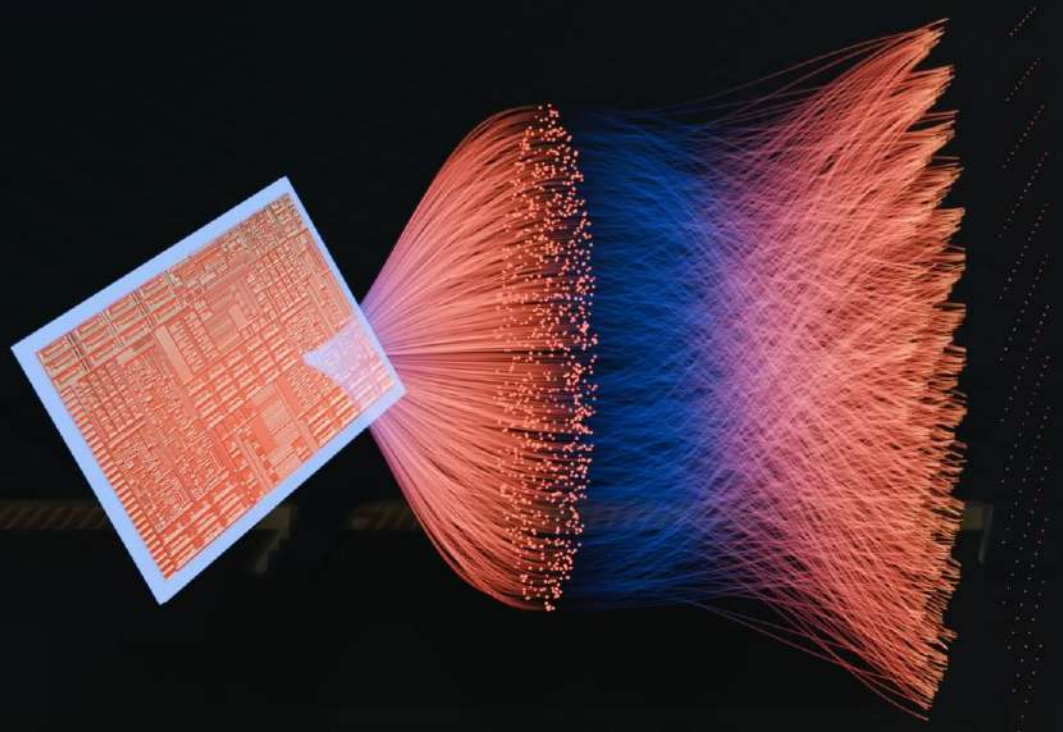


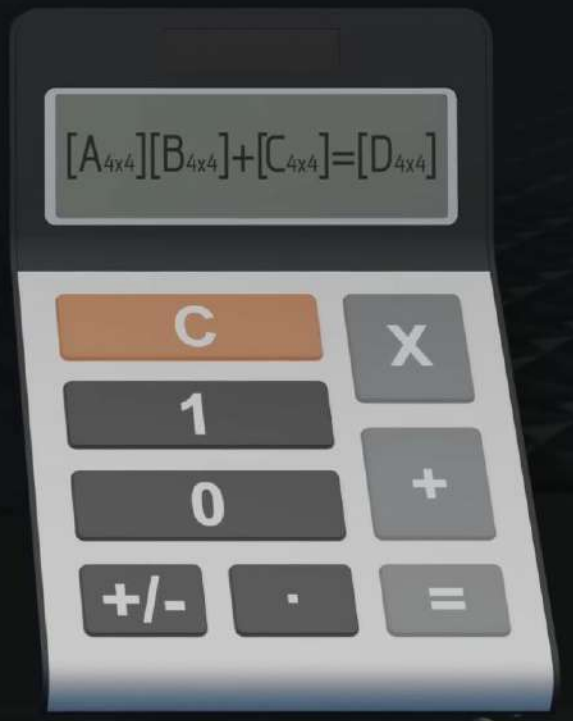


Branch Education


Tensor Cores
[A4x4][B4x4]+[C4x4]=[D4x4]
C
X
1
0
+
+/-
.
=
Branch Education

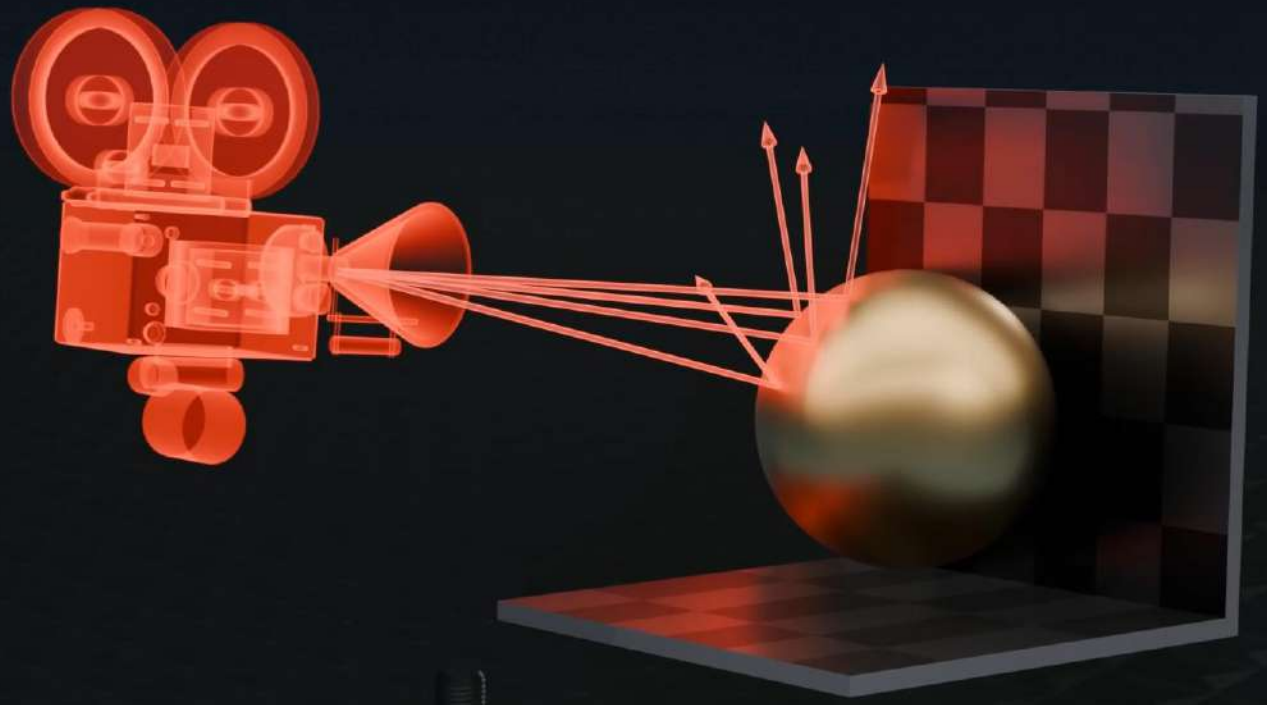
Tensor Cores

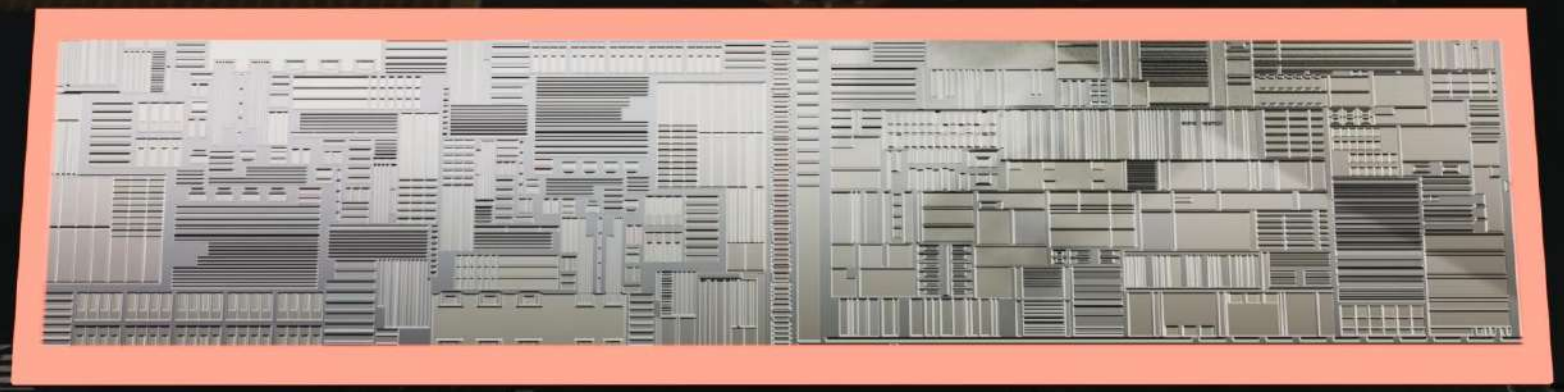




Branch Education

Ray Tracing Cores



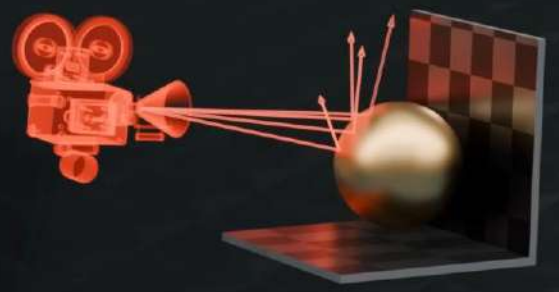


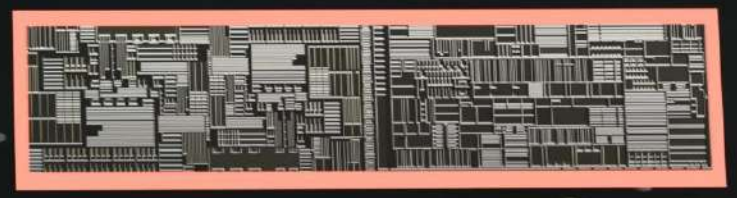
Branch Education

CUDA Cores

Tensor Cores

Ray Tracing Cores

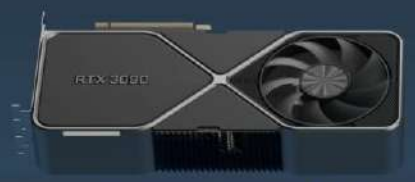




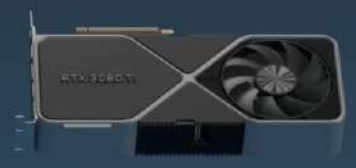
Branch Education

Note: Although the 30 series of GPUs is a bit dated, we're using them because to make accurate 3D models, we needed to teardown a GPU destructively, and we like to do this teardown with broken or defective GPUs.

Nvidia 3080



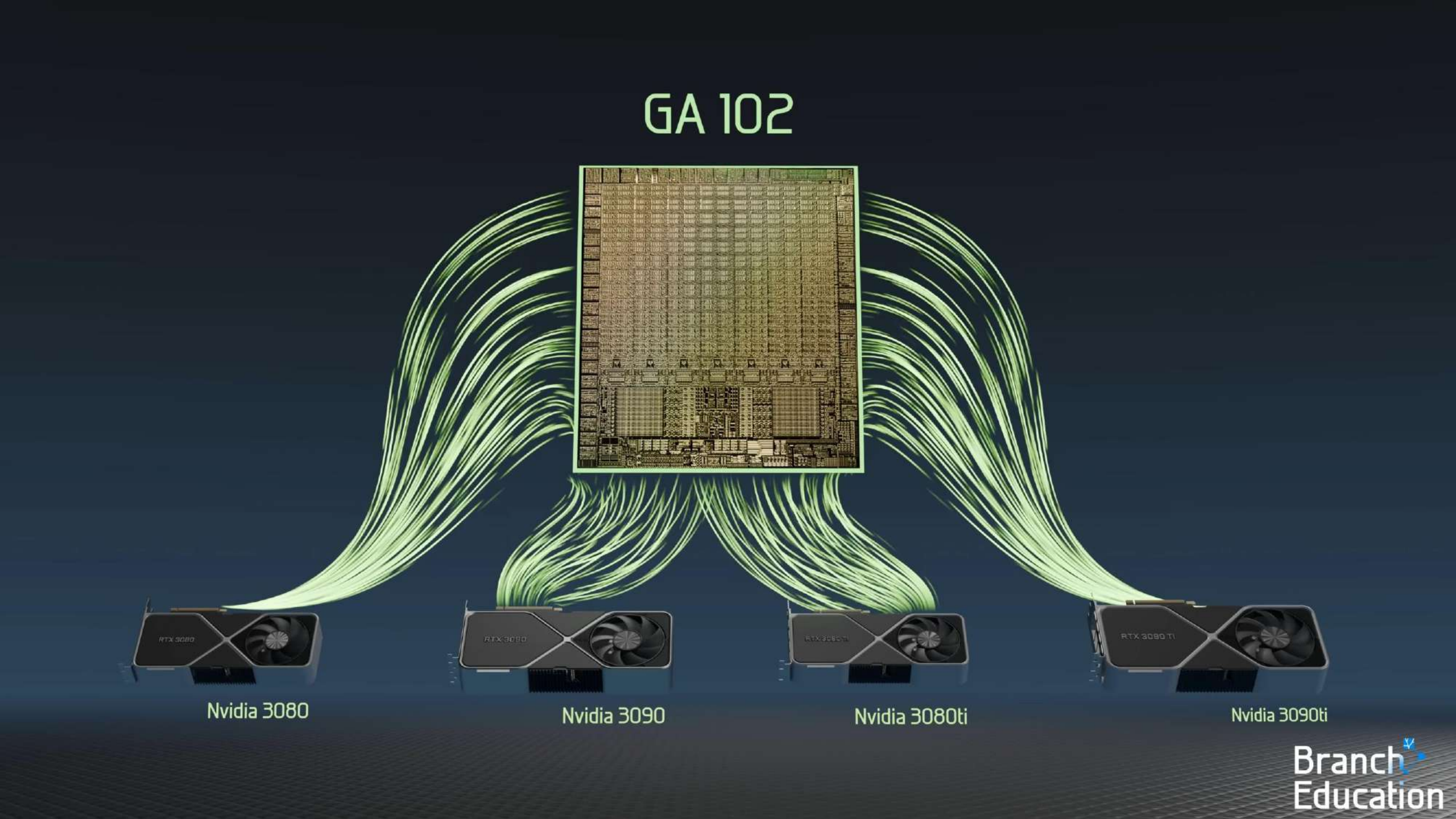
Nvidia 3090



Nvidia 3080ti

Nvidia 3090ti

Branch Education


GA 102
Nvidia 3080
Nvidia 3090
Nvidia 3080ti
Nvidia 3090ti
Branch Education

Nvidia 3080

Nvidia 3090

Nvidia 3080ti

Nvidia 3090ti

Branch Education

Note: Prices based on MSRP.

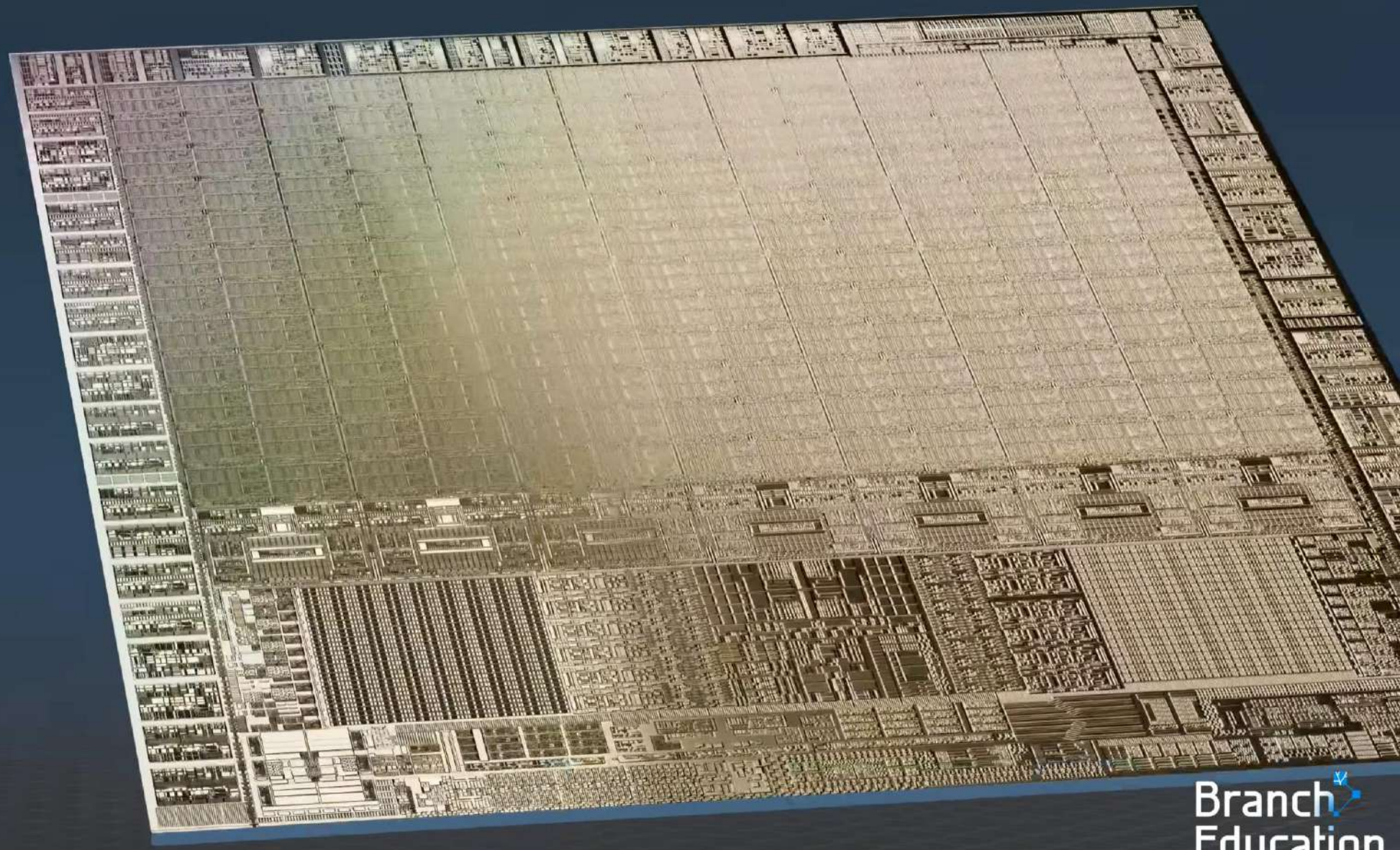
September 1, 2020

September 1, 2020

May 31, 2021

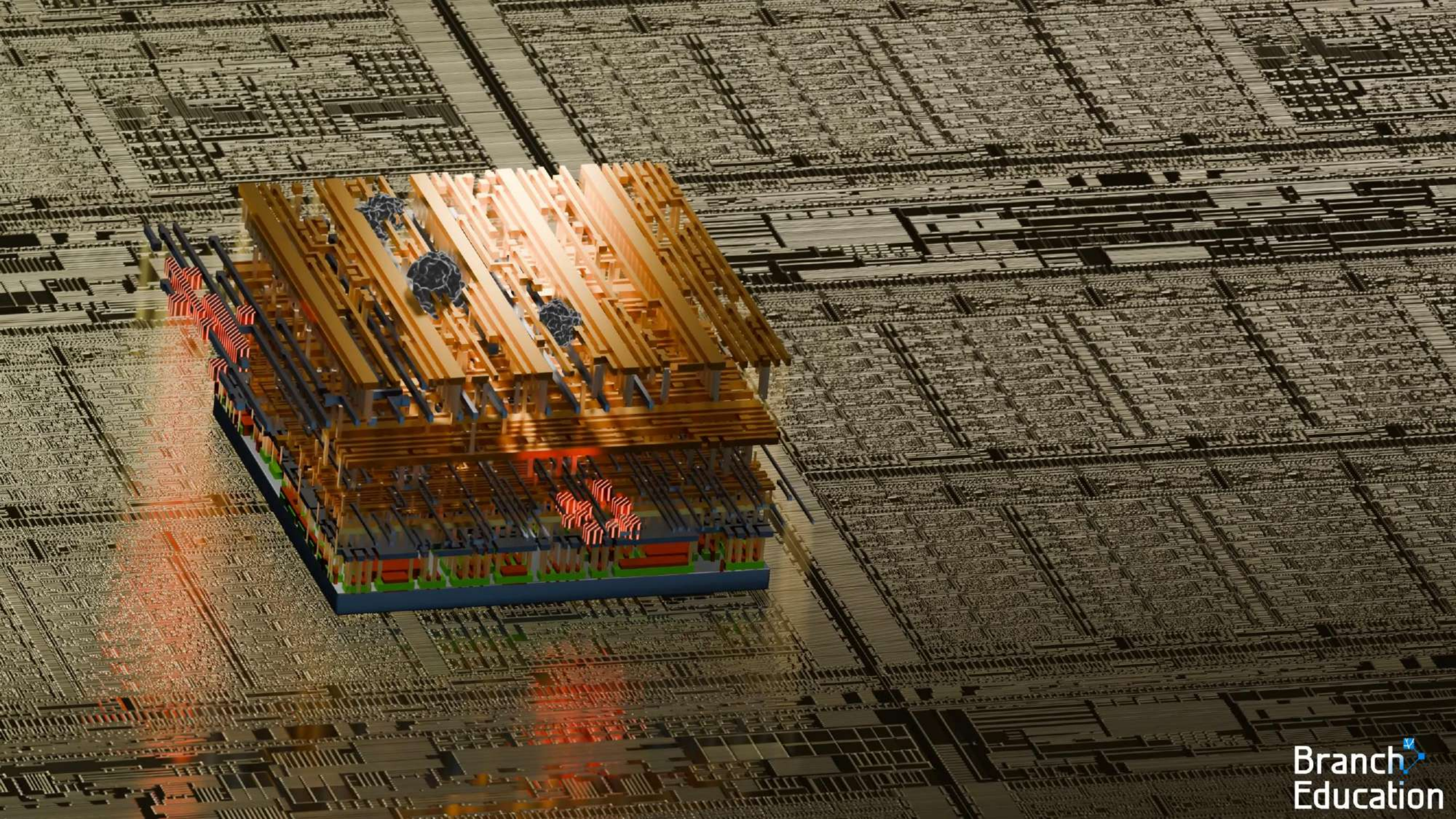
January 27,2022

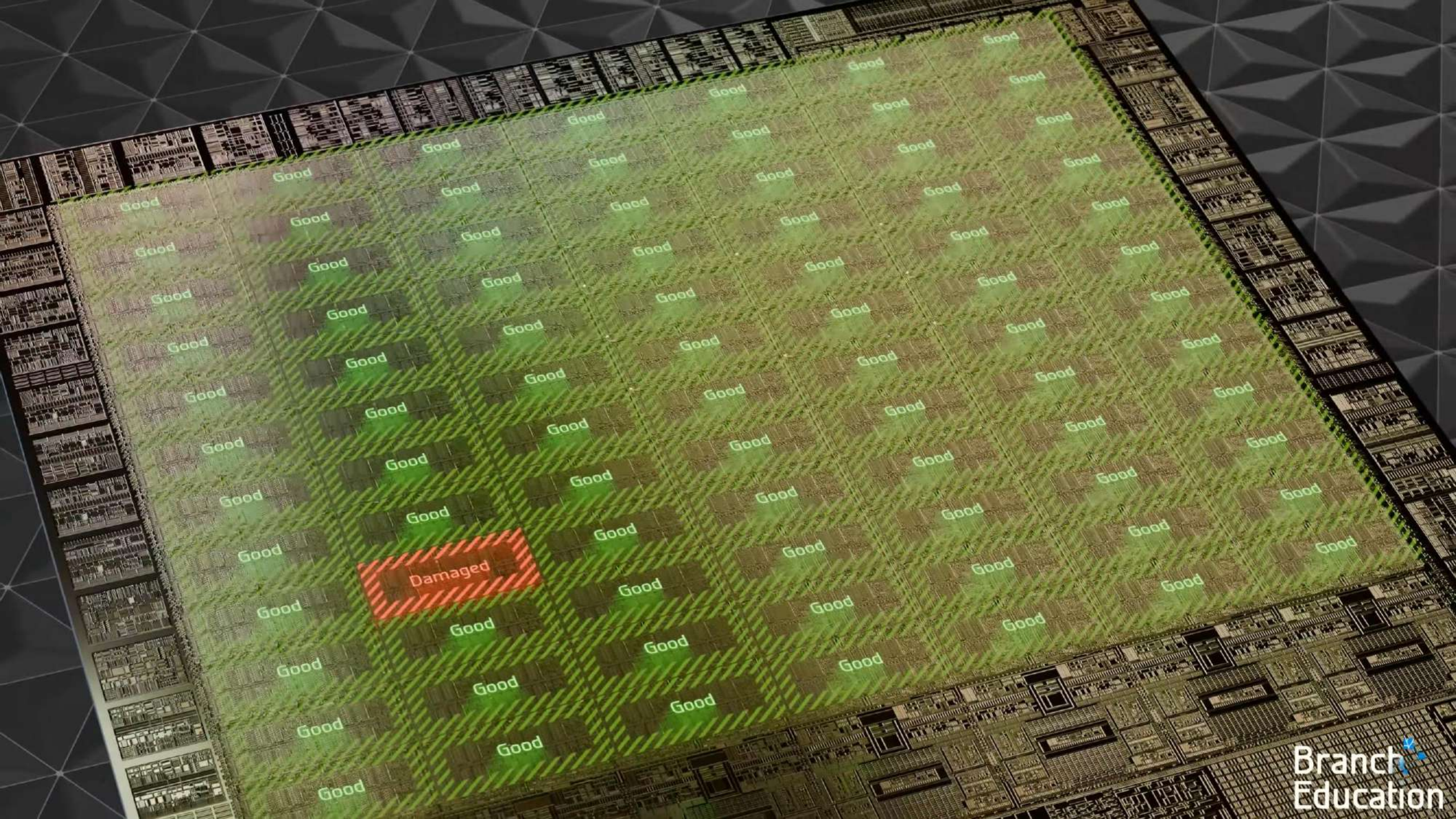
Branch Education



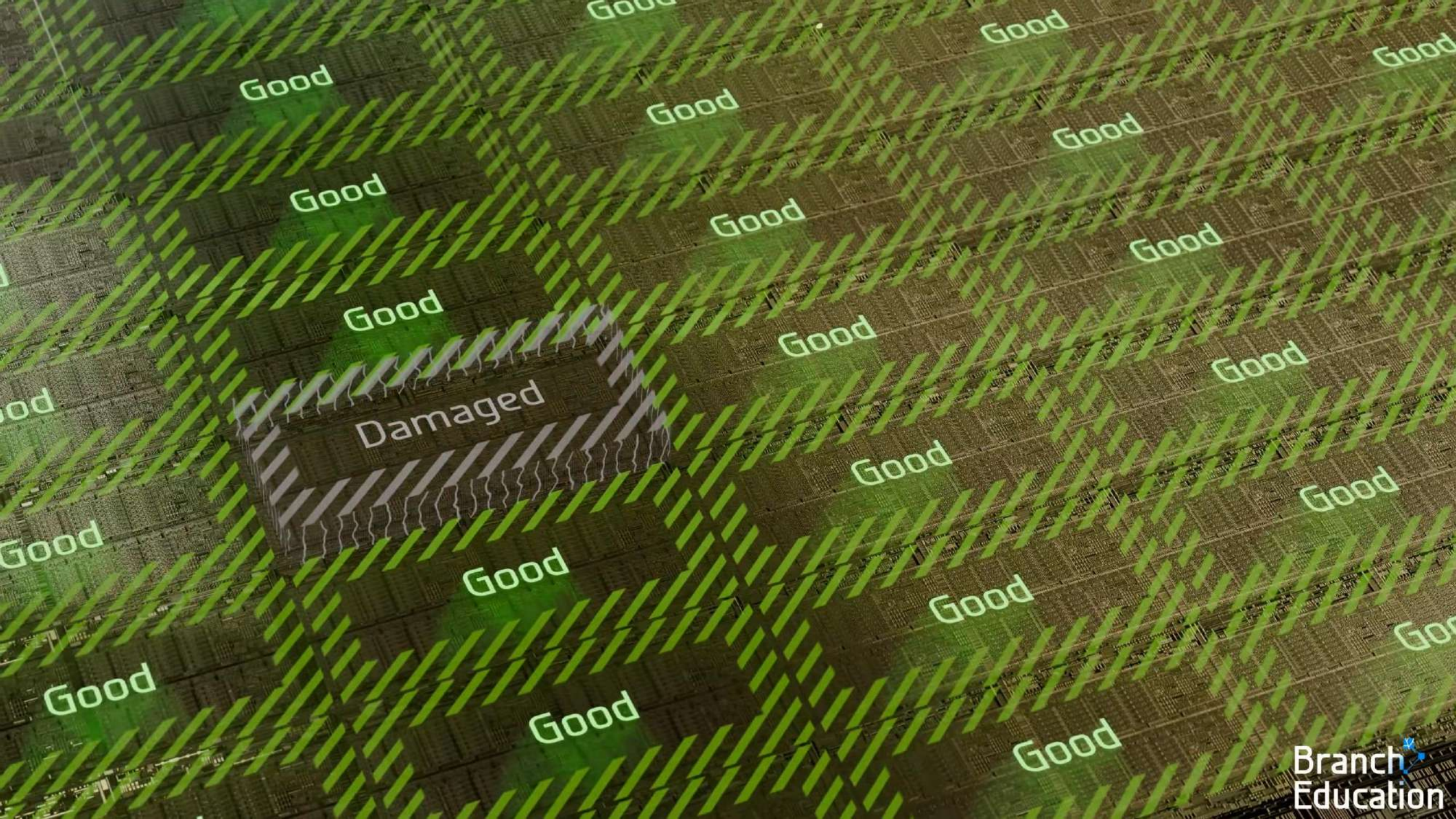
Branch Education

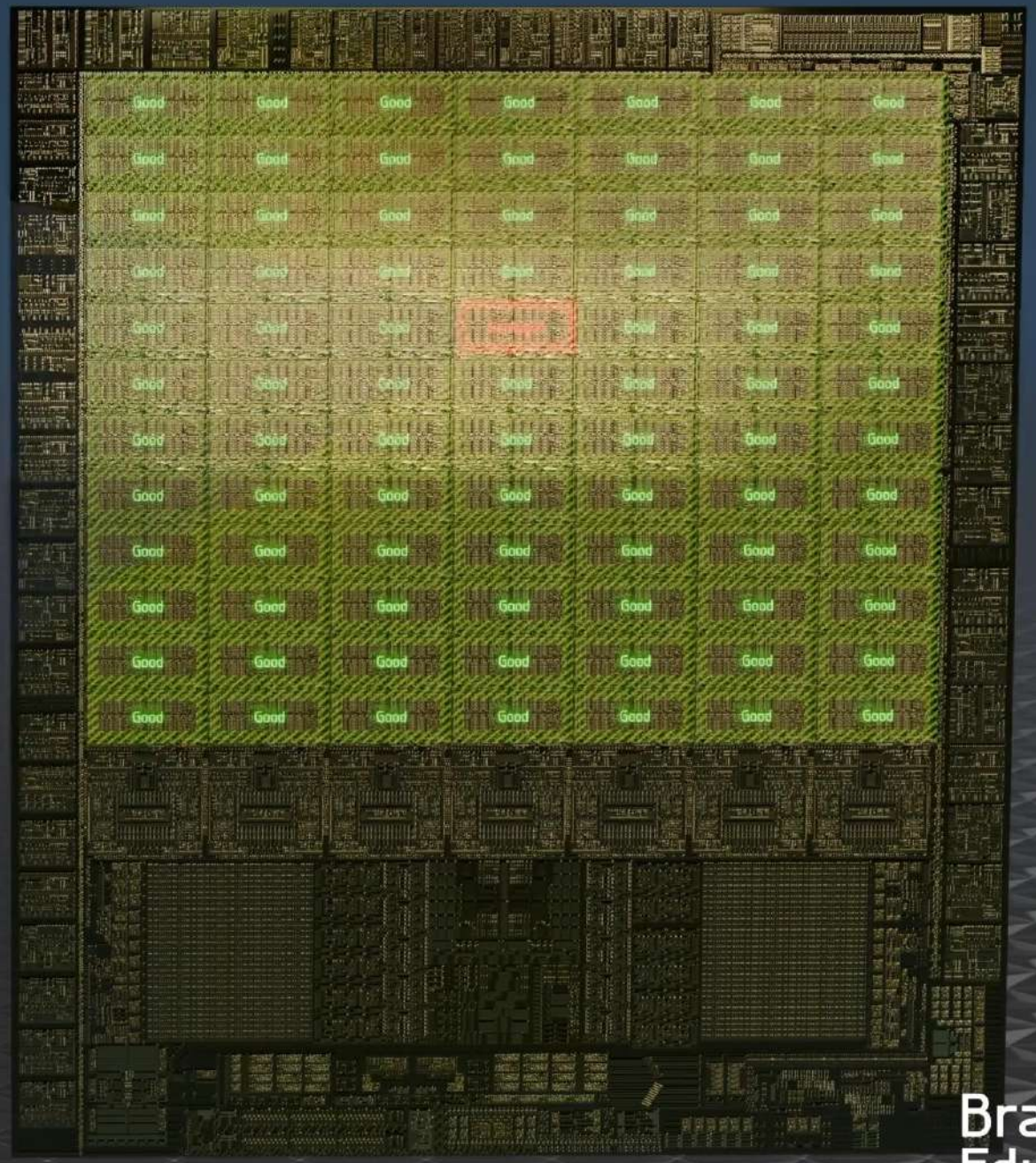
Branch
Education


Branch
Education


Good
Damaged
Branch Education

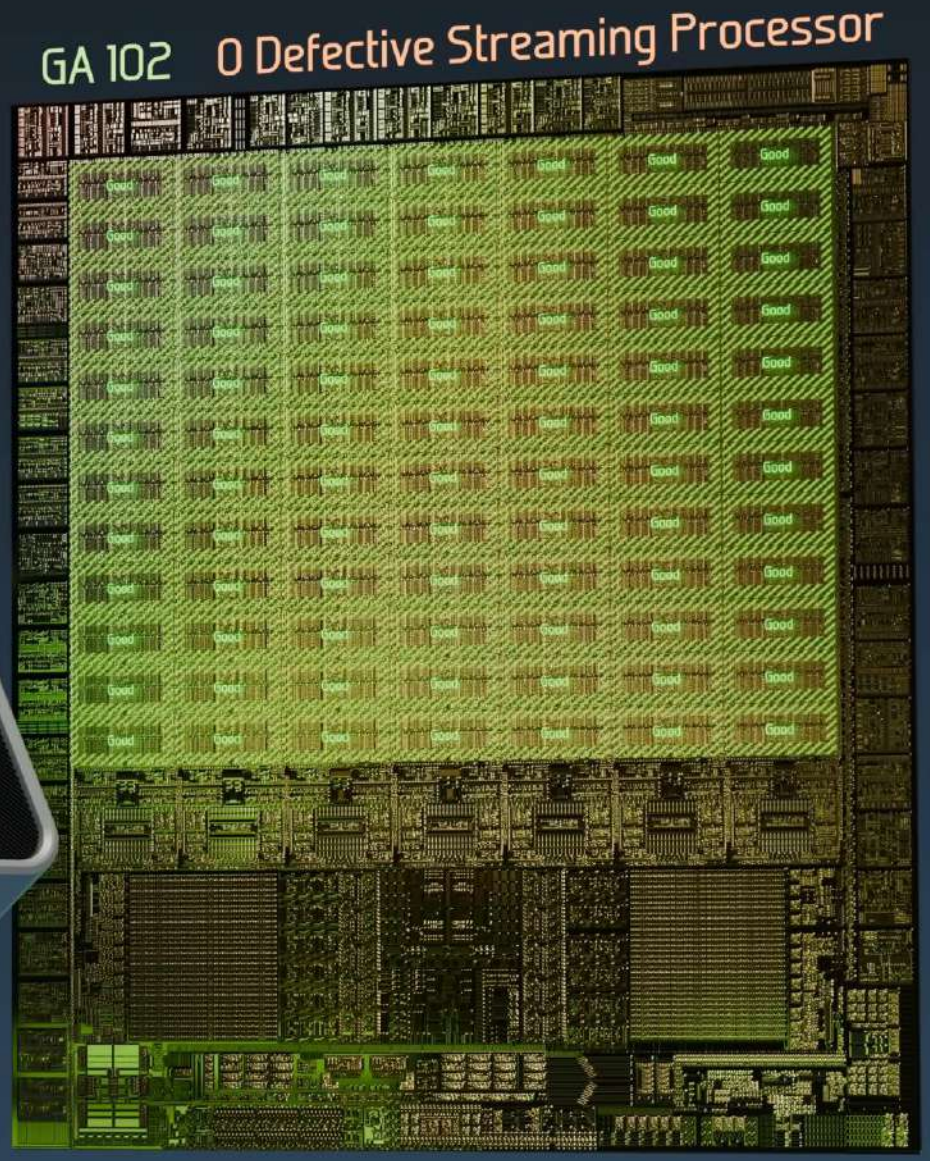
Good
Good
Good
Good
Good
Good
Good
Damaged
Good
Good
Good
Good
Good
Good
Branch Education


Good
Damaged
Branch Education



Branch Education

Nvidia 3080
Nvidia 3090
Nvidia 3080ti
Nvidia 3090ti
Branch Education

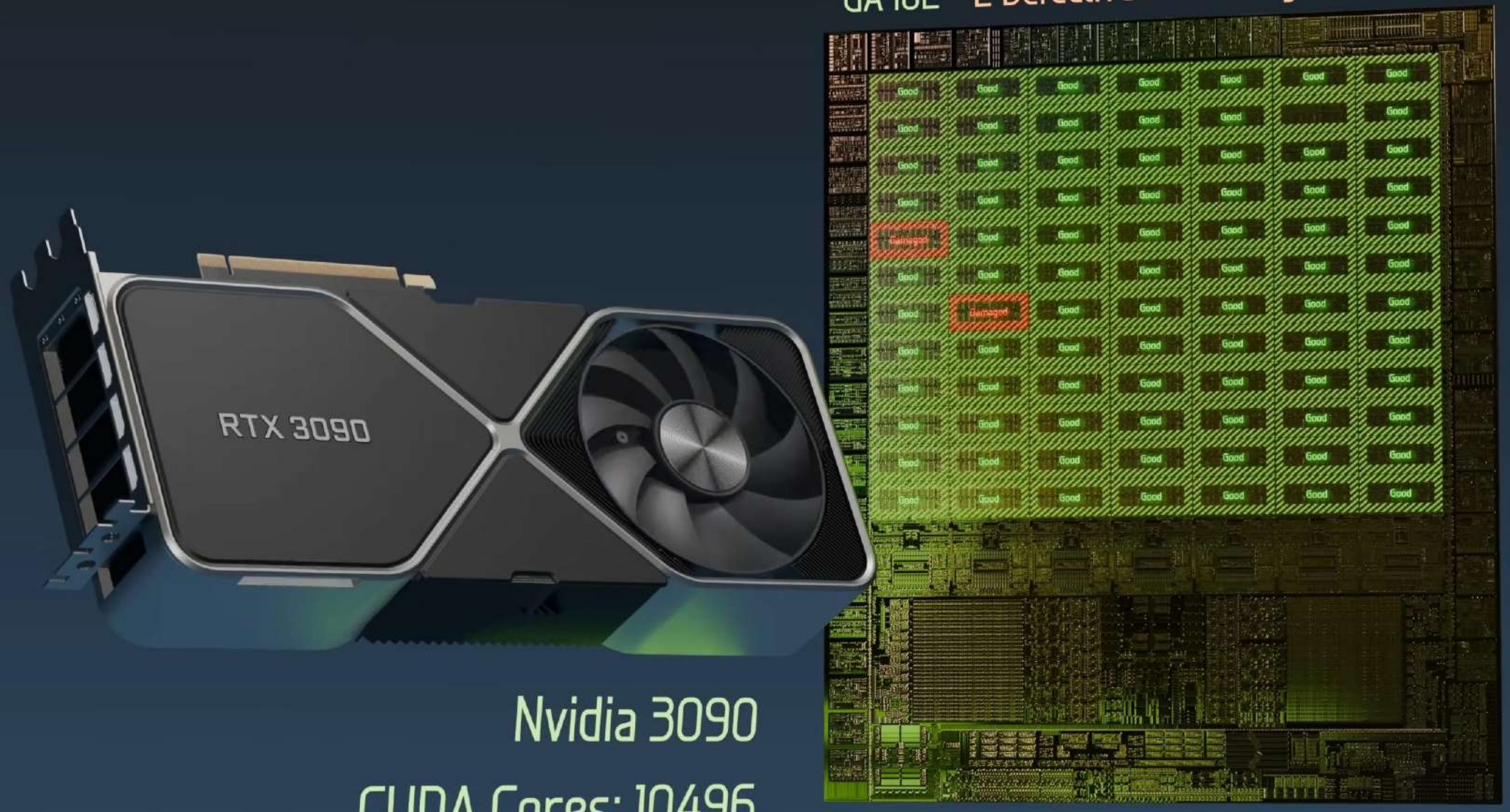


Nvidia 3090ti

CUDA Cores: 10752

Branch Education

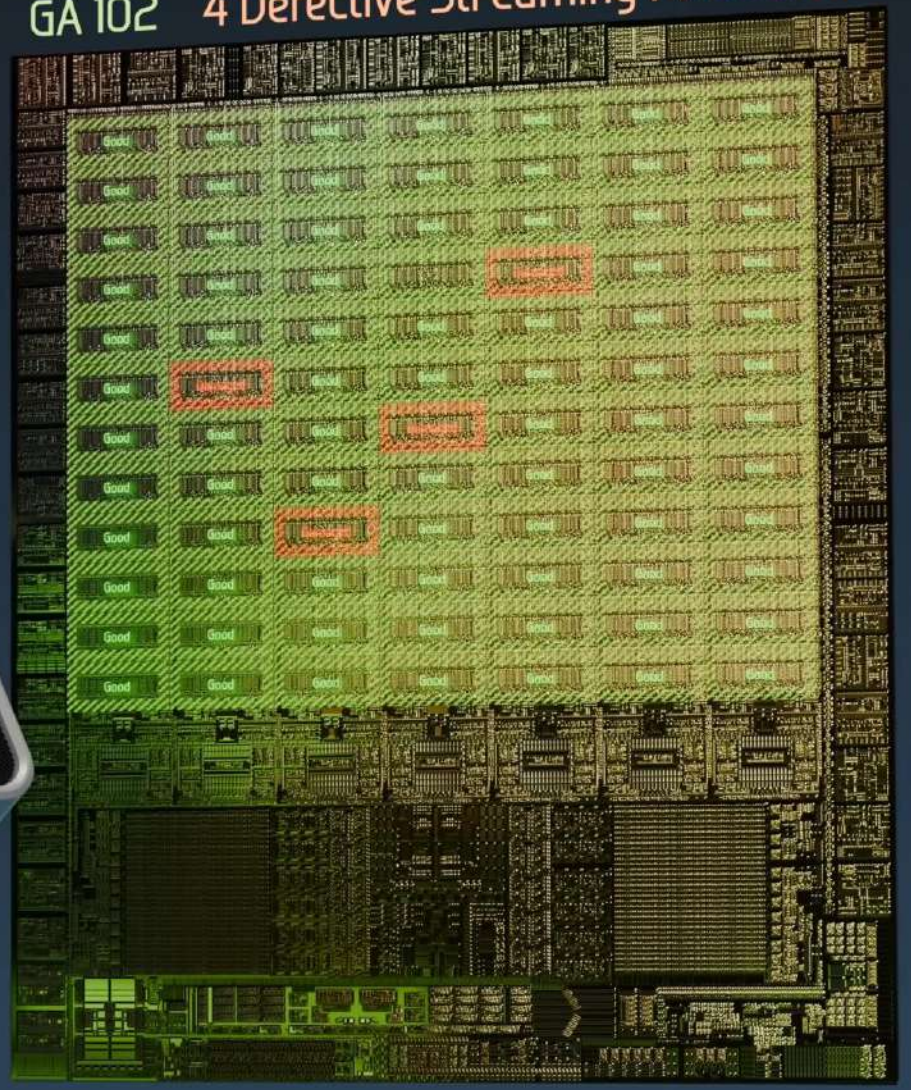
GA 102 2 Defective Streaming Processor



Nvidia 3090

CUDA Cores: 10496

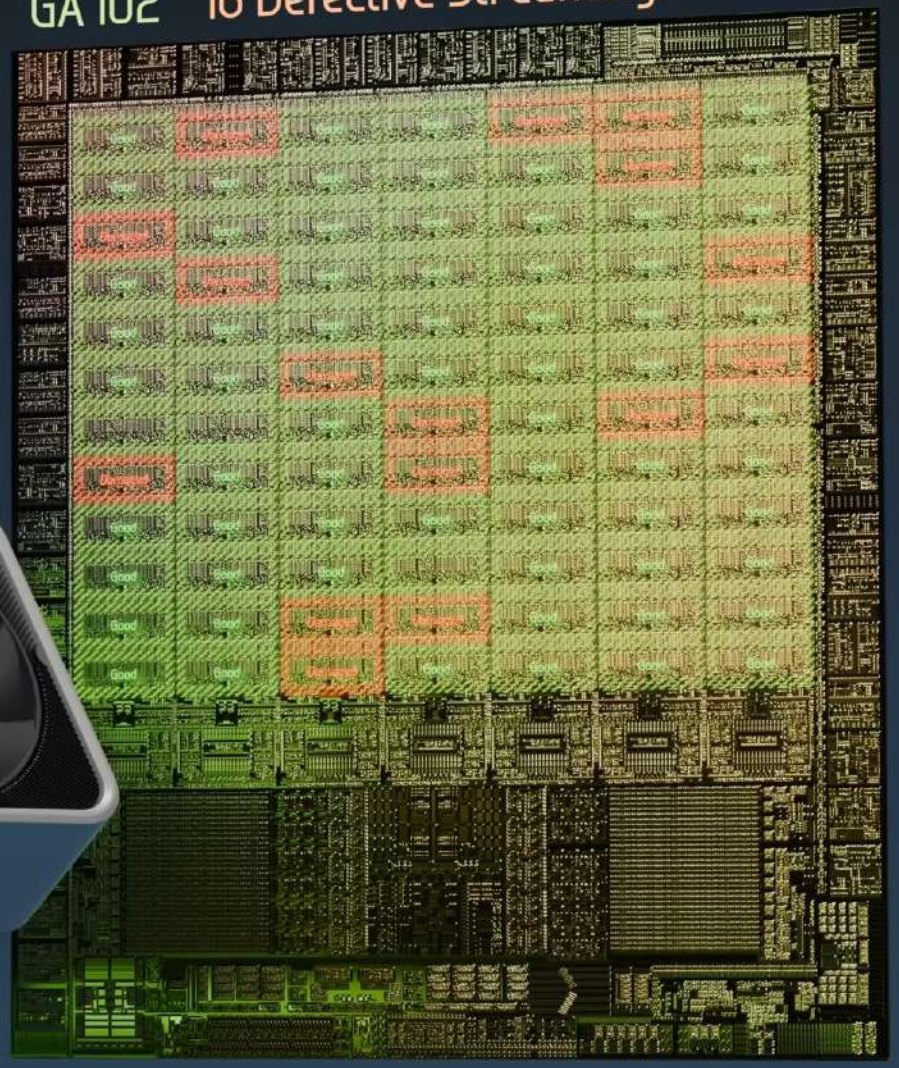
Branch Education



Nvidia 3080ti

CUDA Cores: 10240

Branch Education



Nvidia 3080

CUDA Cores: 8704

Branch Education

Note: Newer graphics cards will also undergo similar binning.

Clock Speed

Nvidia 3080
CUDA Cores: 8704

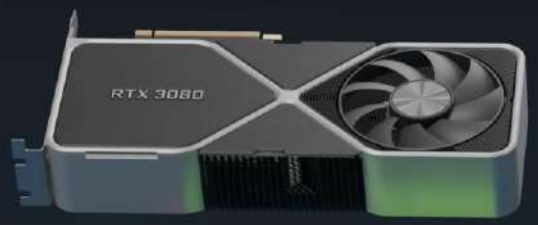
Nvidia 3090
CUDA Cores: 10496

Nvidia 3080ti
CUDA Cores: 10240

Nvidia 3090ti
CUDA Cores: 10752

Branch Education

Note: Newer graphics cards will also undergo similar binning.



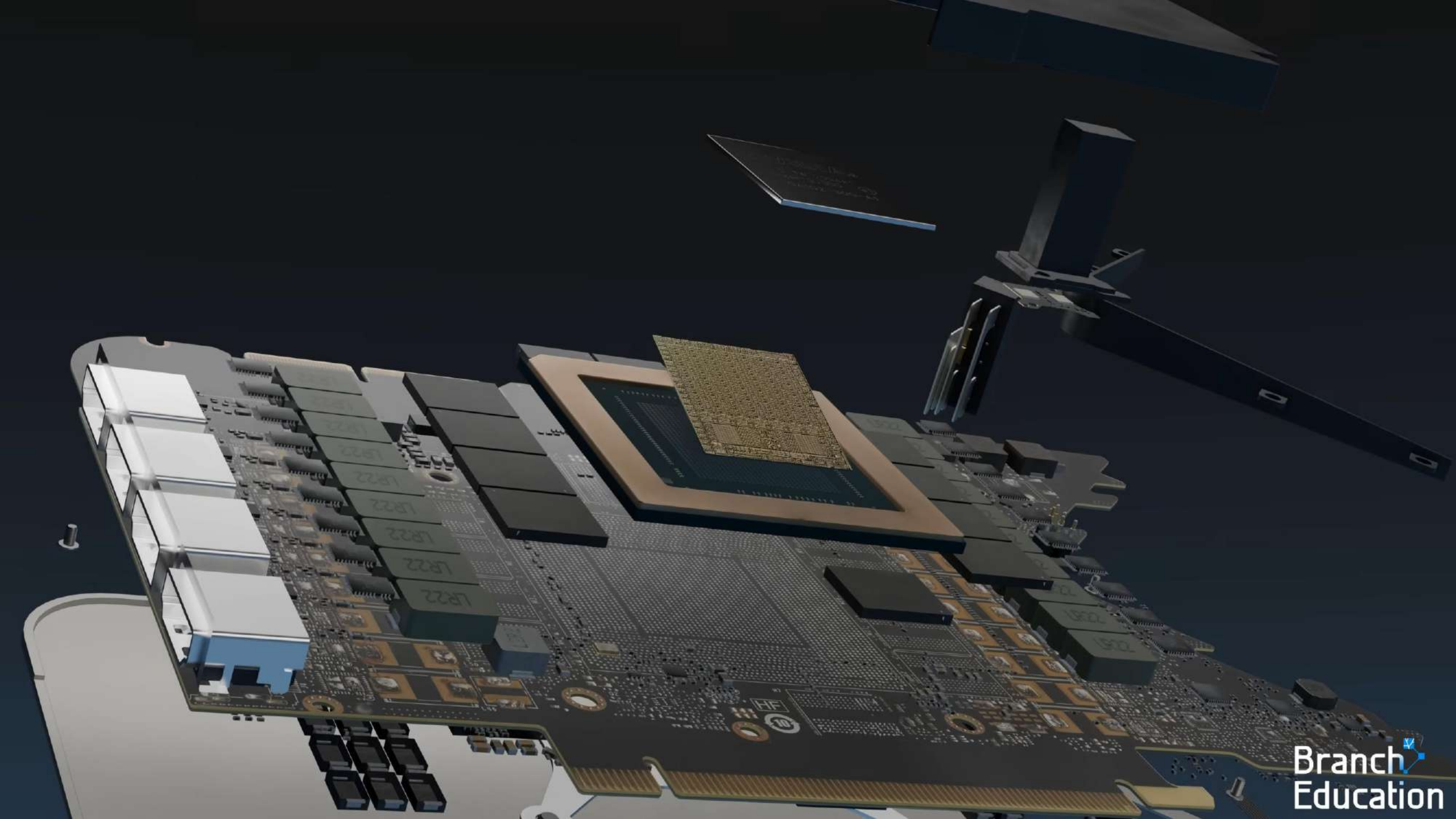
Nvidia 3080
CUDA Cores: 8704
Clock speed: 1260 MHz
12 GB GDDR6X

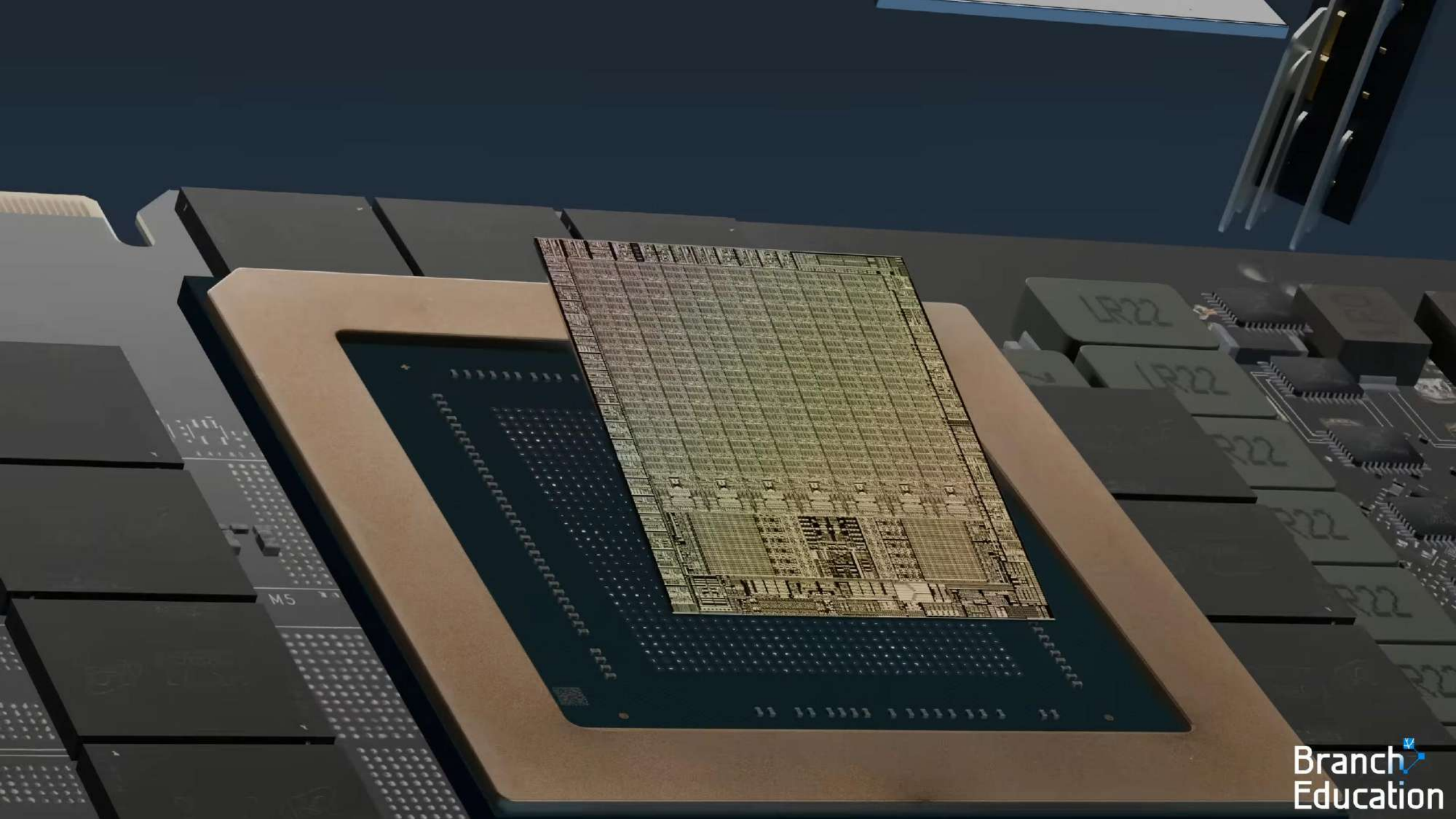
Nvidia 3090
CUDA Cores: 10496
Clock speed: 1395 MHz
24 GB GDDR6X

Nvidia 3080ti
CUDA Cores: 10240
Clock speed: 1395 MHz
12 GB GDDR6X

Nvidia 3090ti
CUDA Cores: 10752
Clock speed: 1395 MHz
24 GB GDDR6X

Branch Education


Branch
Education

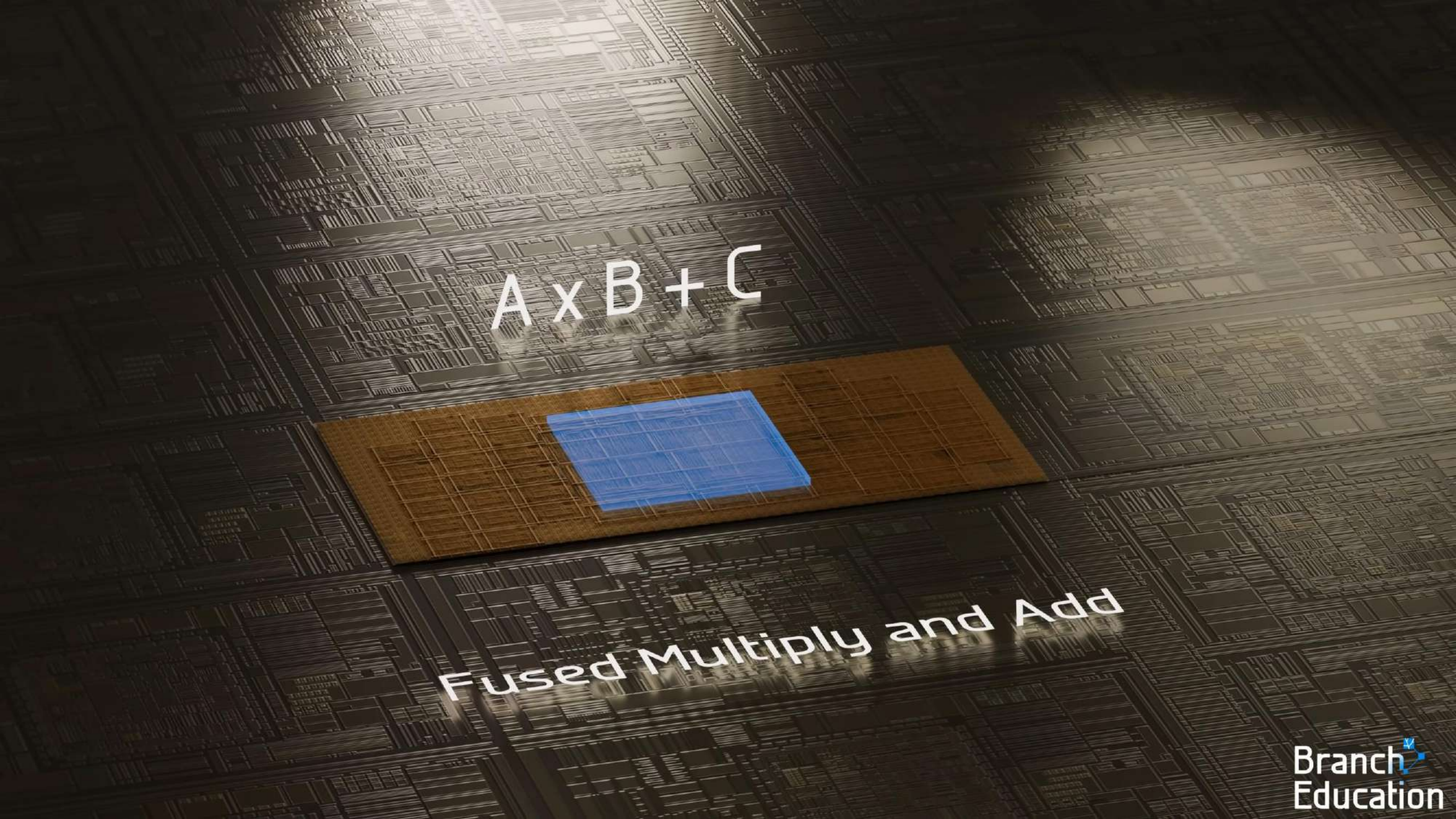

M5
Branch
Education

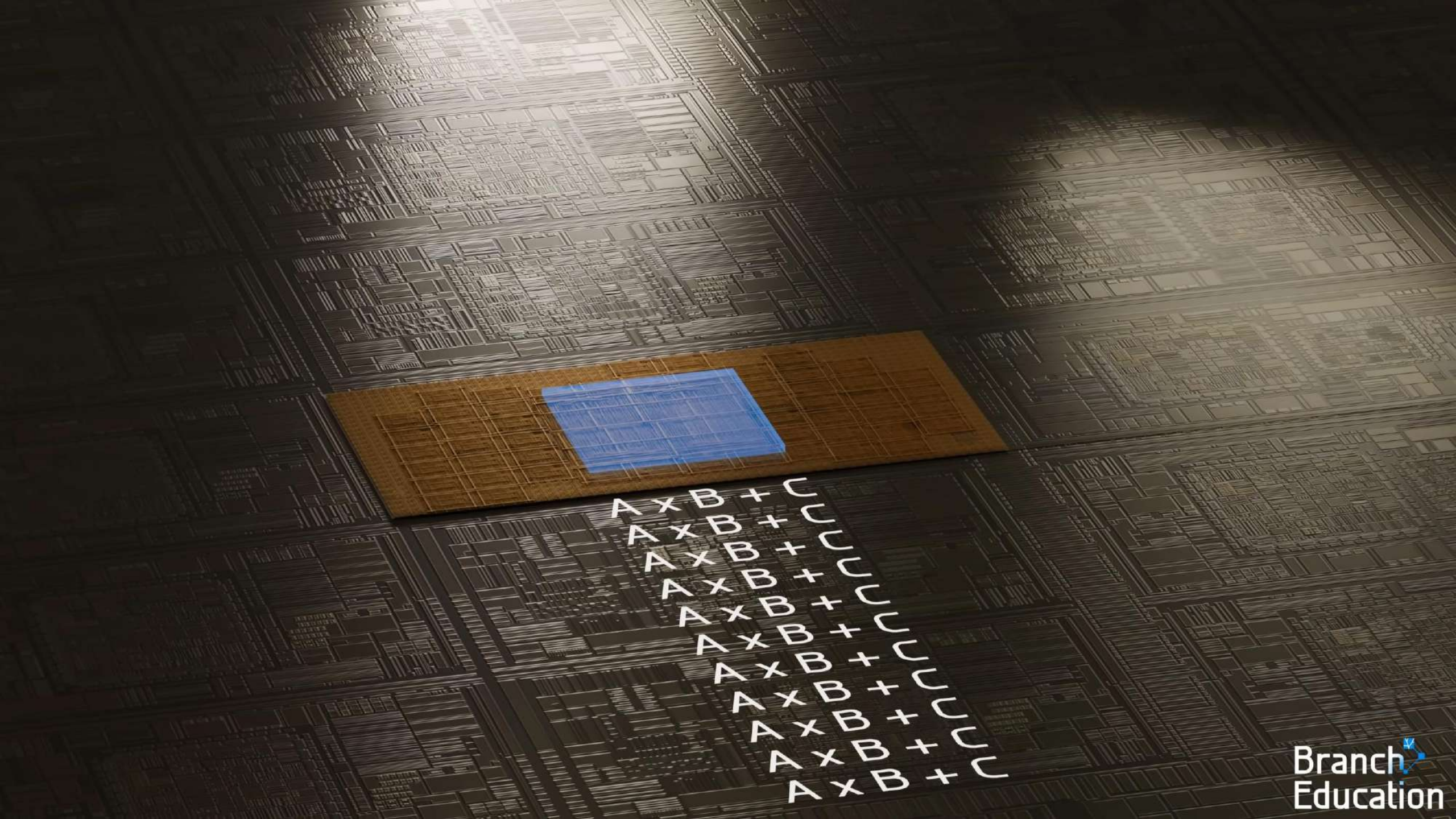
Branch
Education

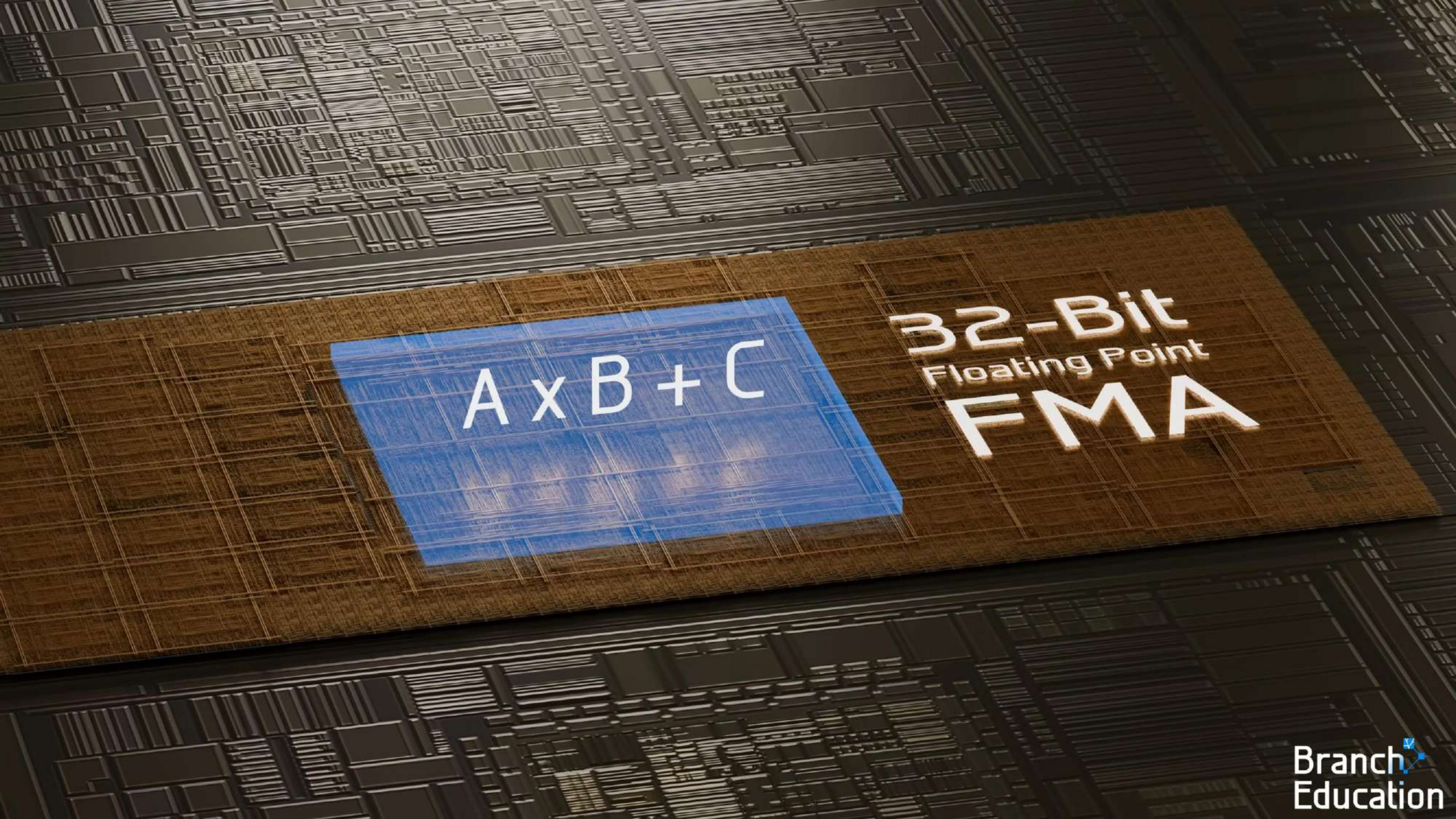
Branch
Education

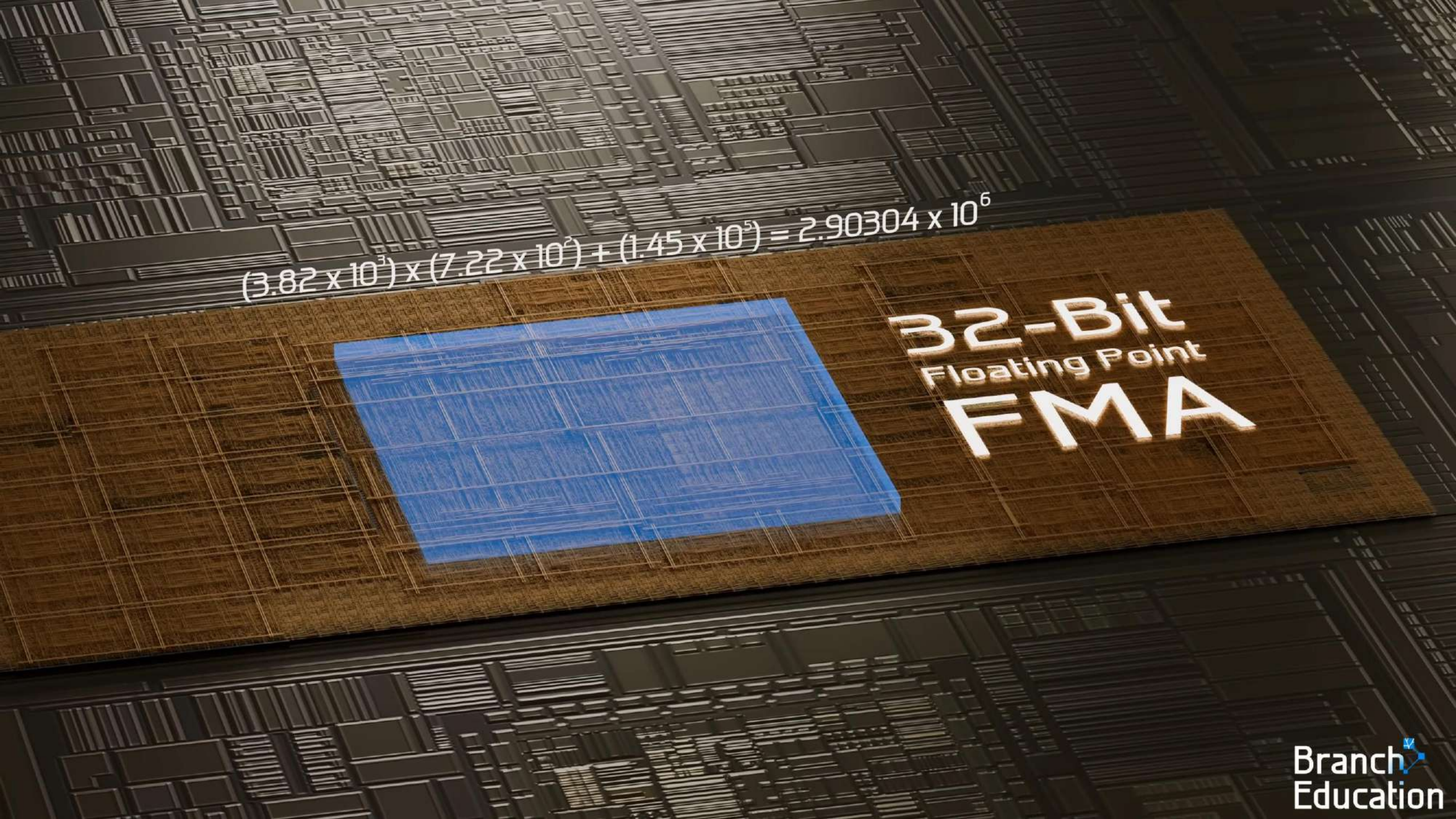
Branch
Education

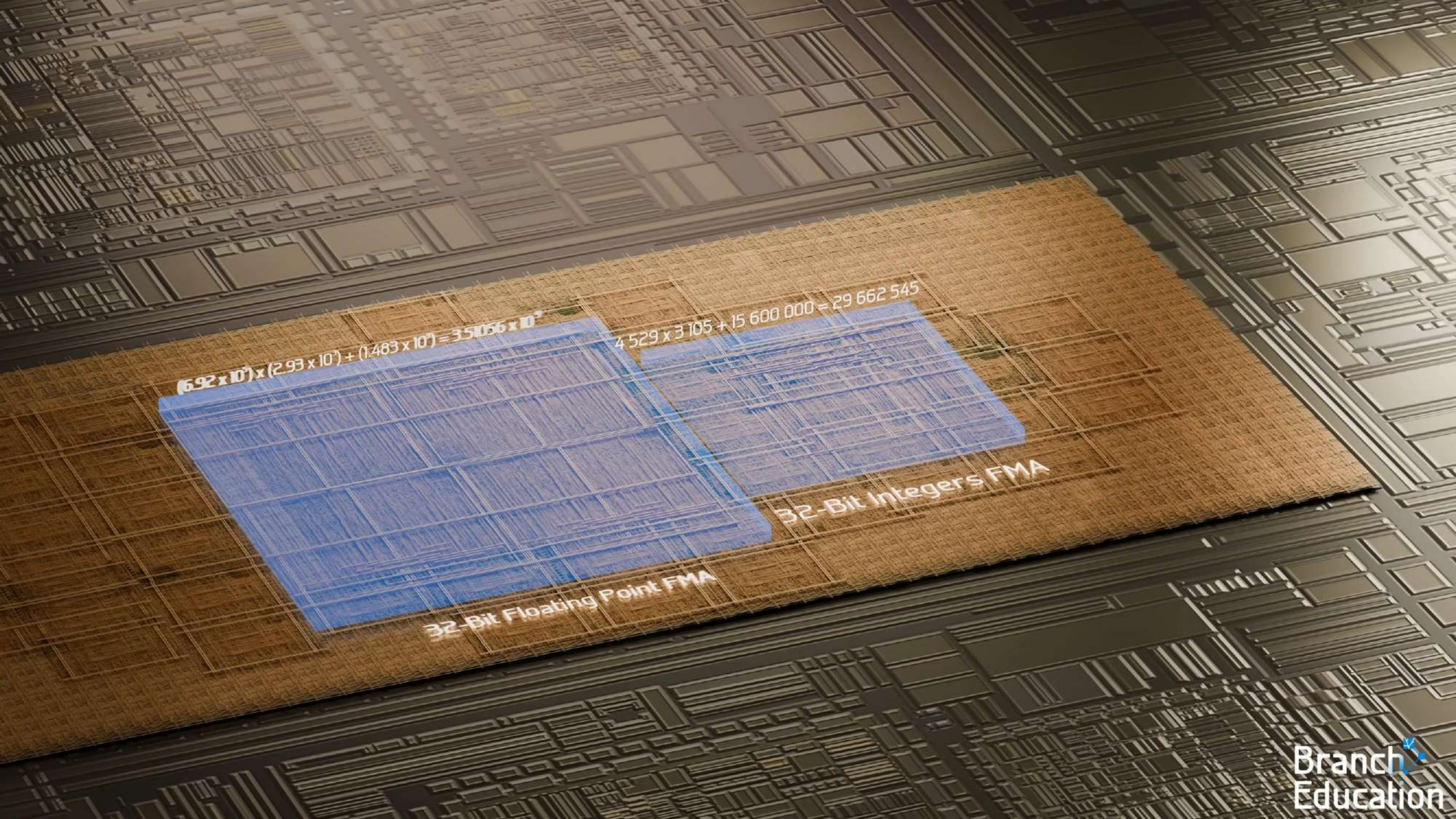
410,000 Transistors
Branch
Education

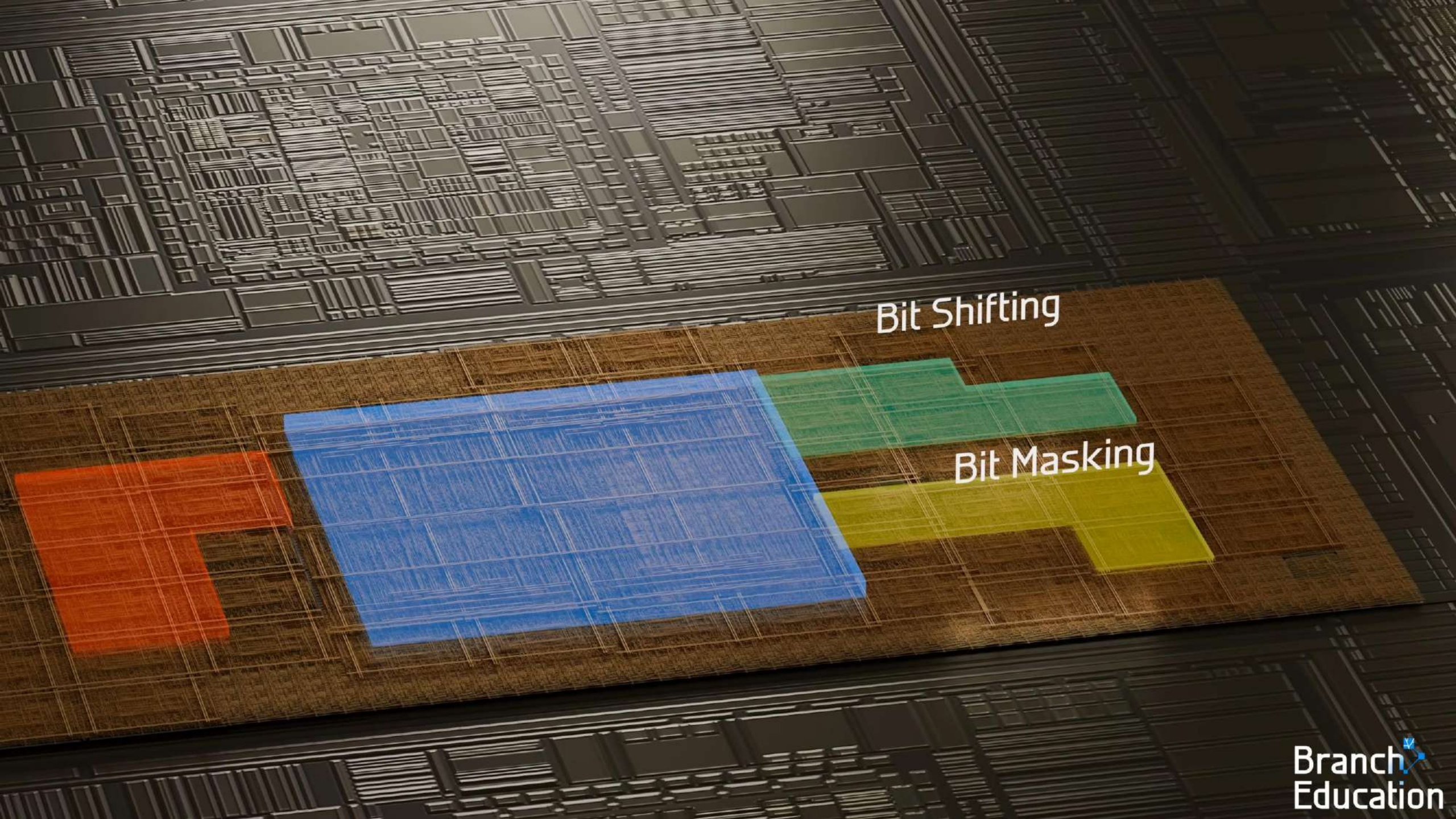

A x B + C
Fused Multiply and Add
Branch
Education

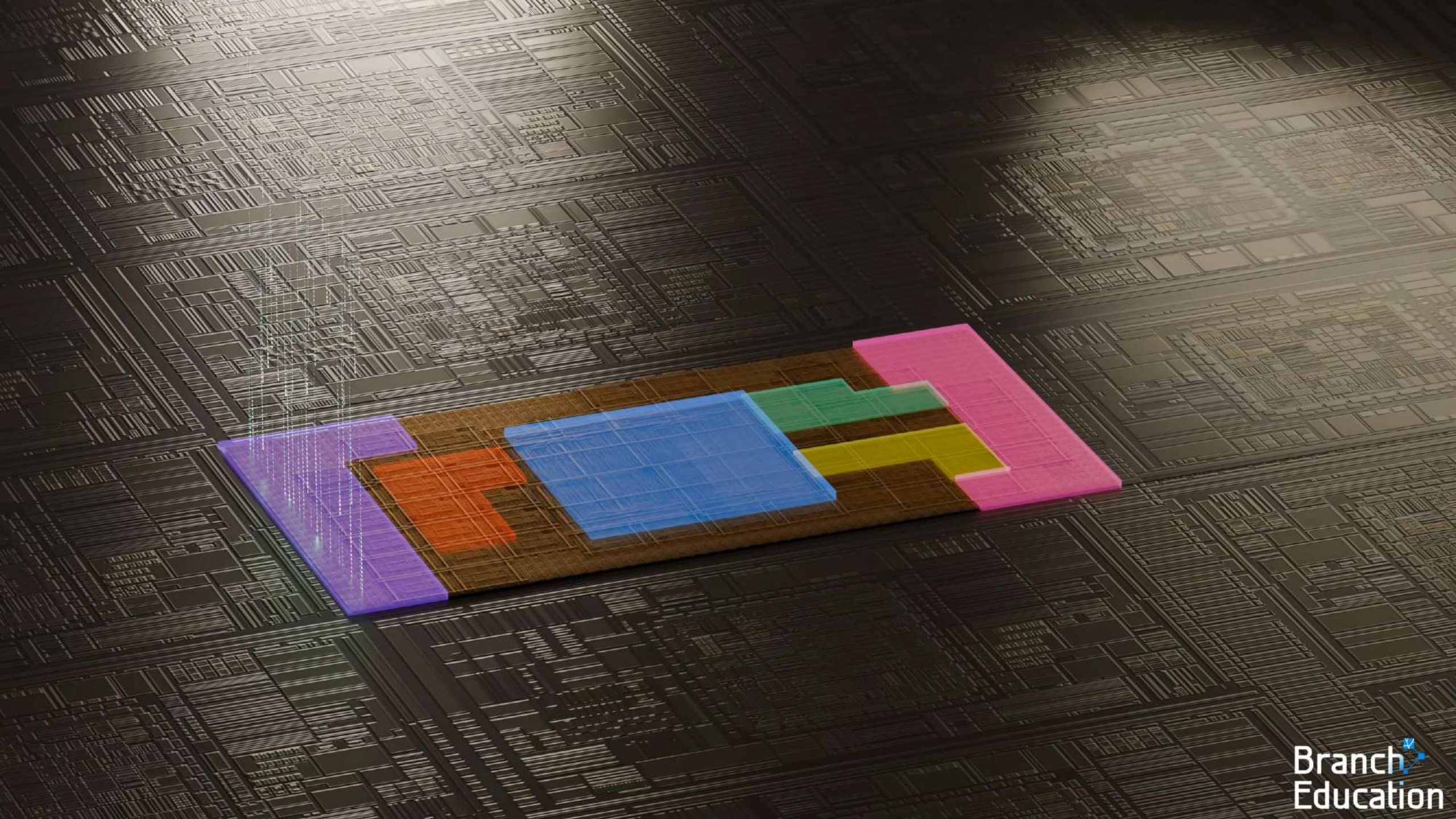

A x B + C
A x B + C
A x B + C
A x B + C
A x B + C
A x B + C
A x B + C
A x B + C
A x B + C
A x B + C
Branch
Education

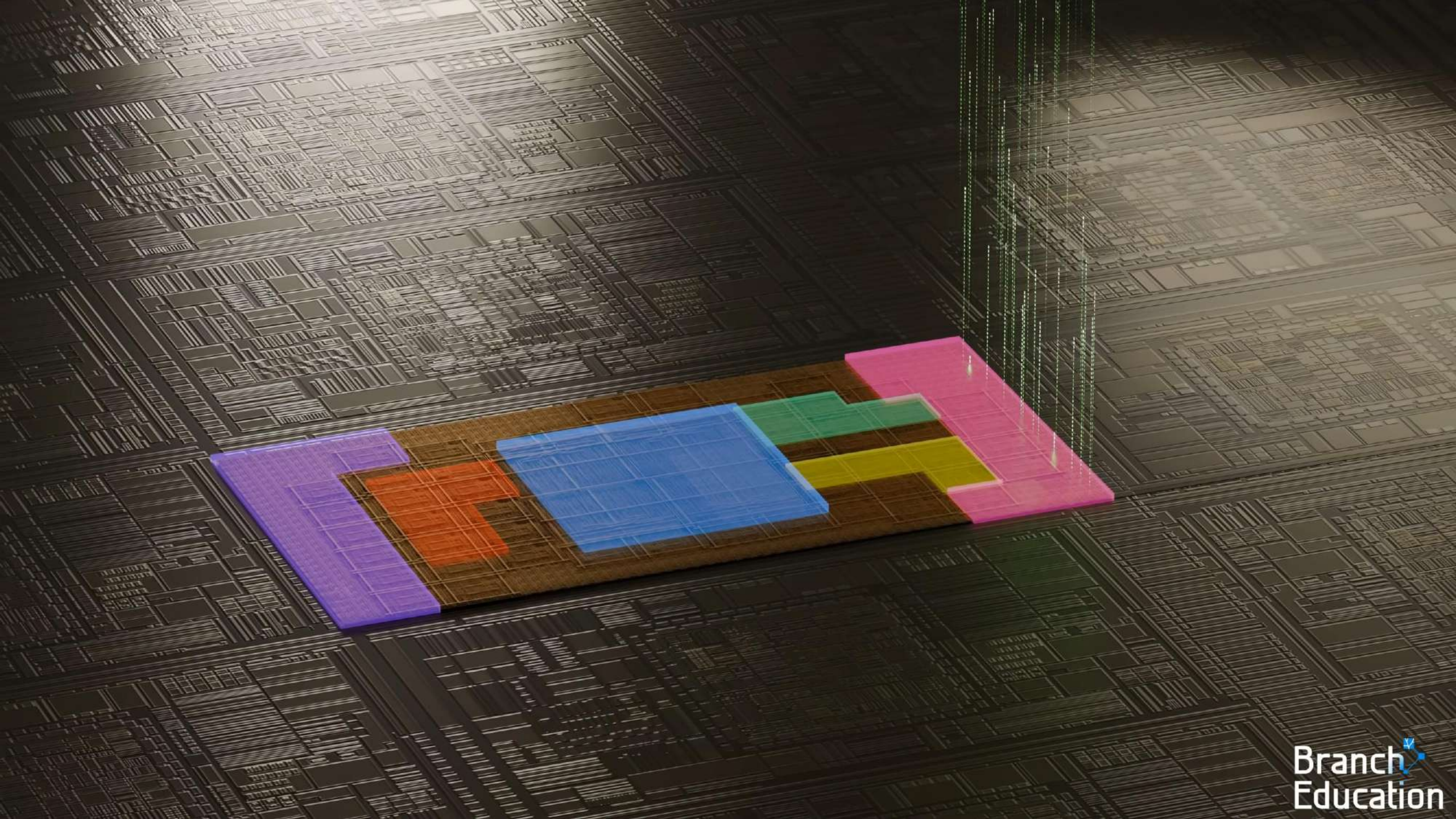

A x B + C
32-Bit
Floating Point
FMA
Branch
Education


$(3.82 \times 10^3) \times (7.22 \times 10^2) + (1.45 \times 10^5) = 2.90304 \times 10^6$
32-Bit
Floating Point
FMA
Branch
Education

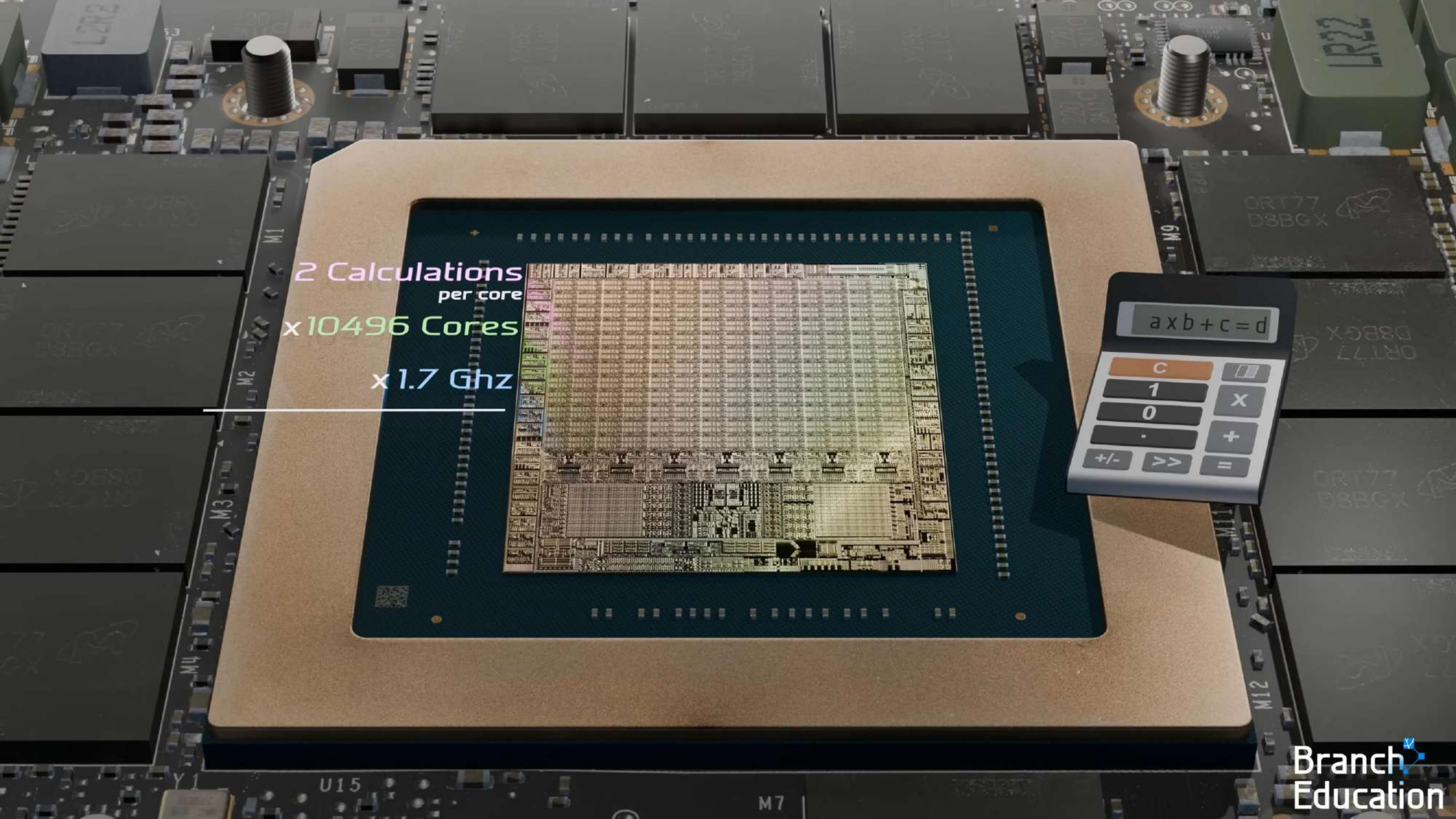

(6.92 x 10^5) x (2.93 x 10^2) + (1.483 x 10^1) = 3.5056 x 10^7
4 529 x 3 105 + 15 600 000 = 29 662 545
32-Bit Integers FMA
32-Bit Floating Point FMA
Branch Education

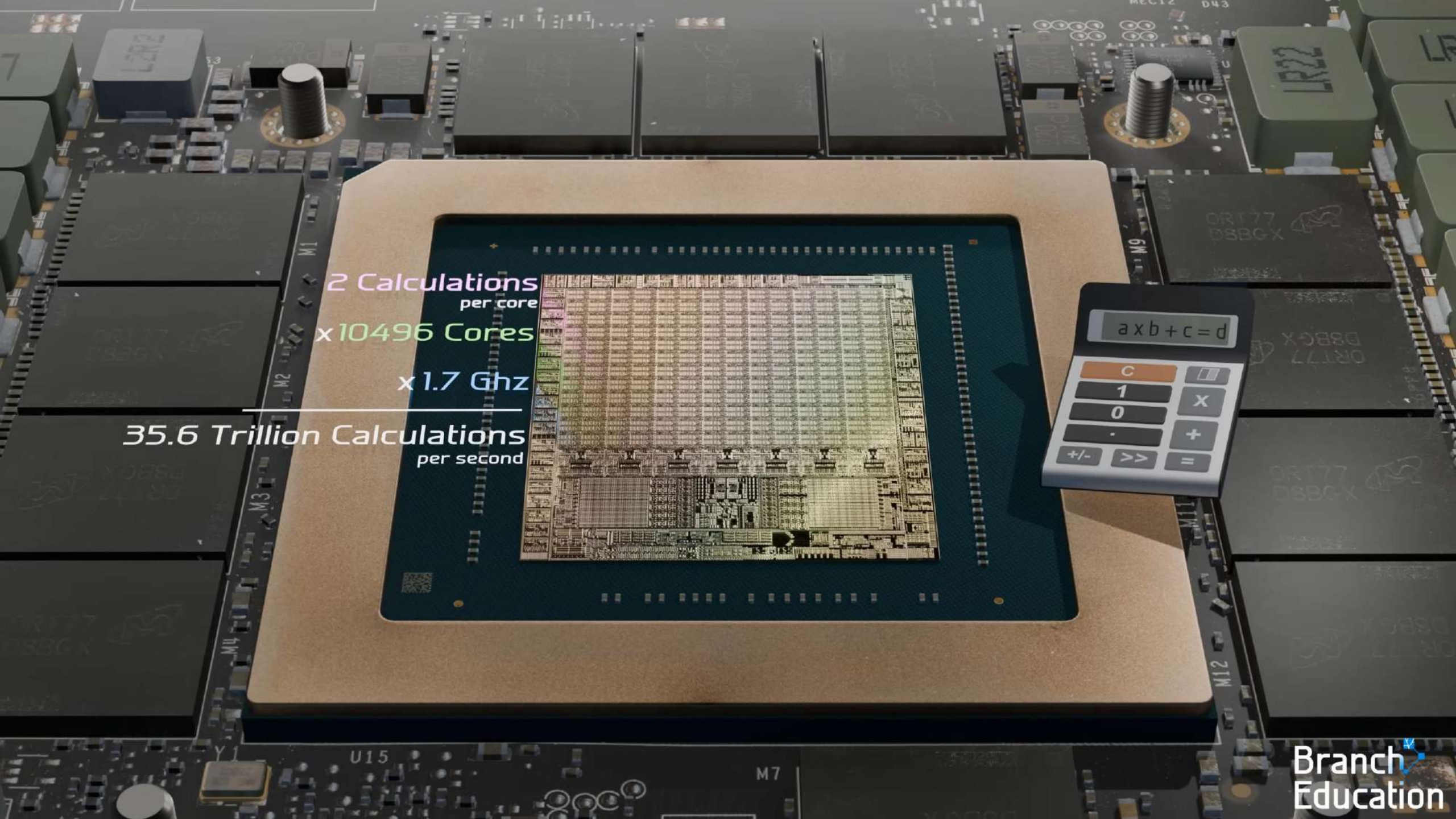

Bit Shifting
Bit Masking
Branch
Education

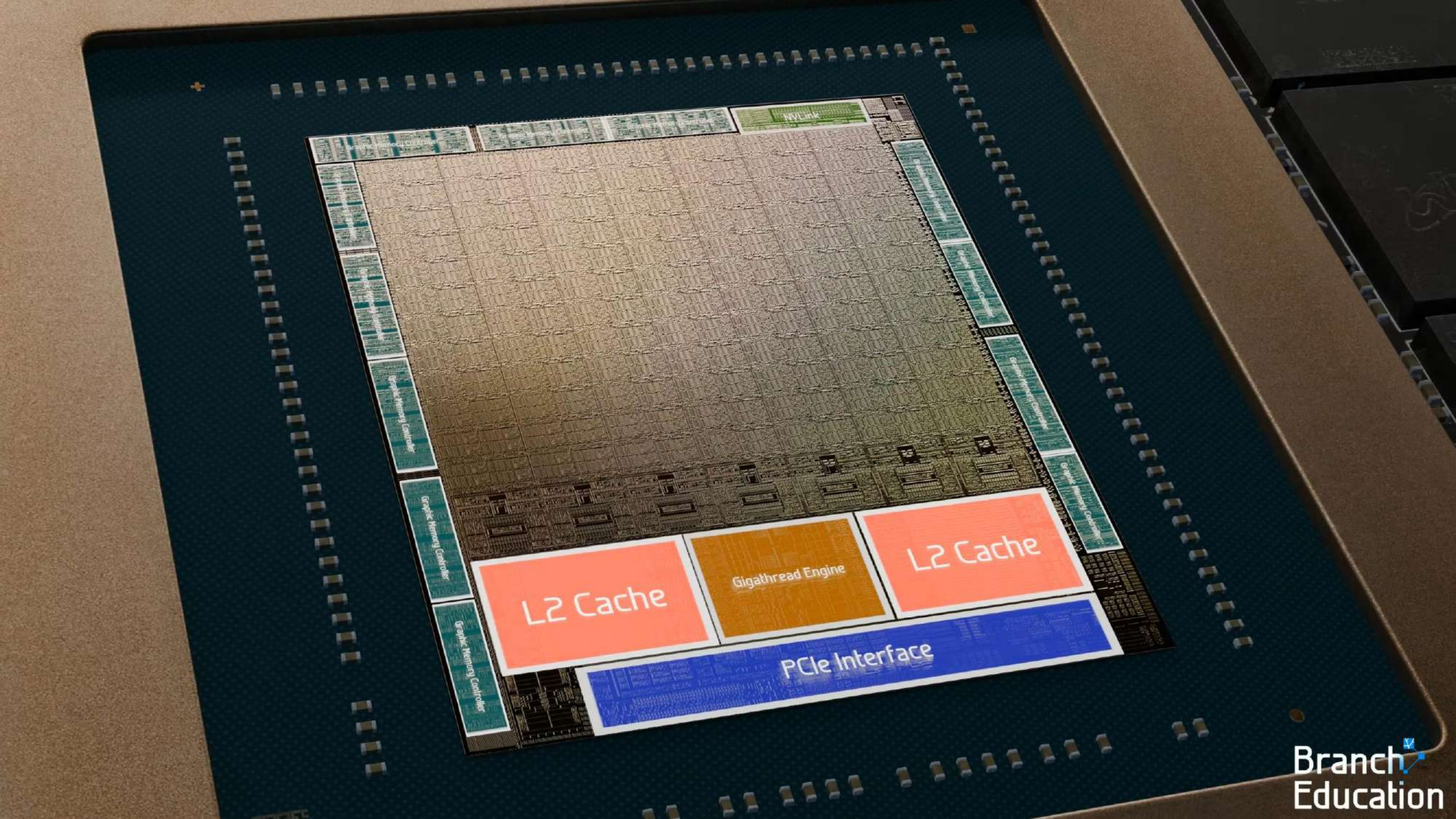

Branch
Education

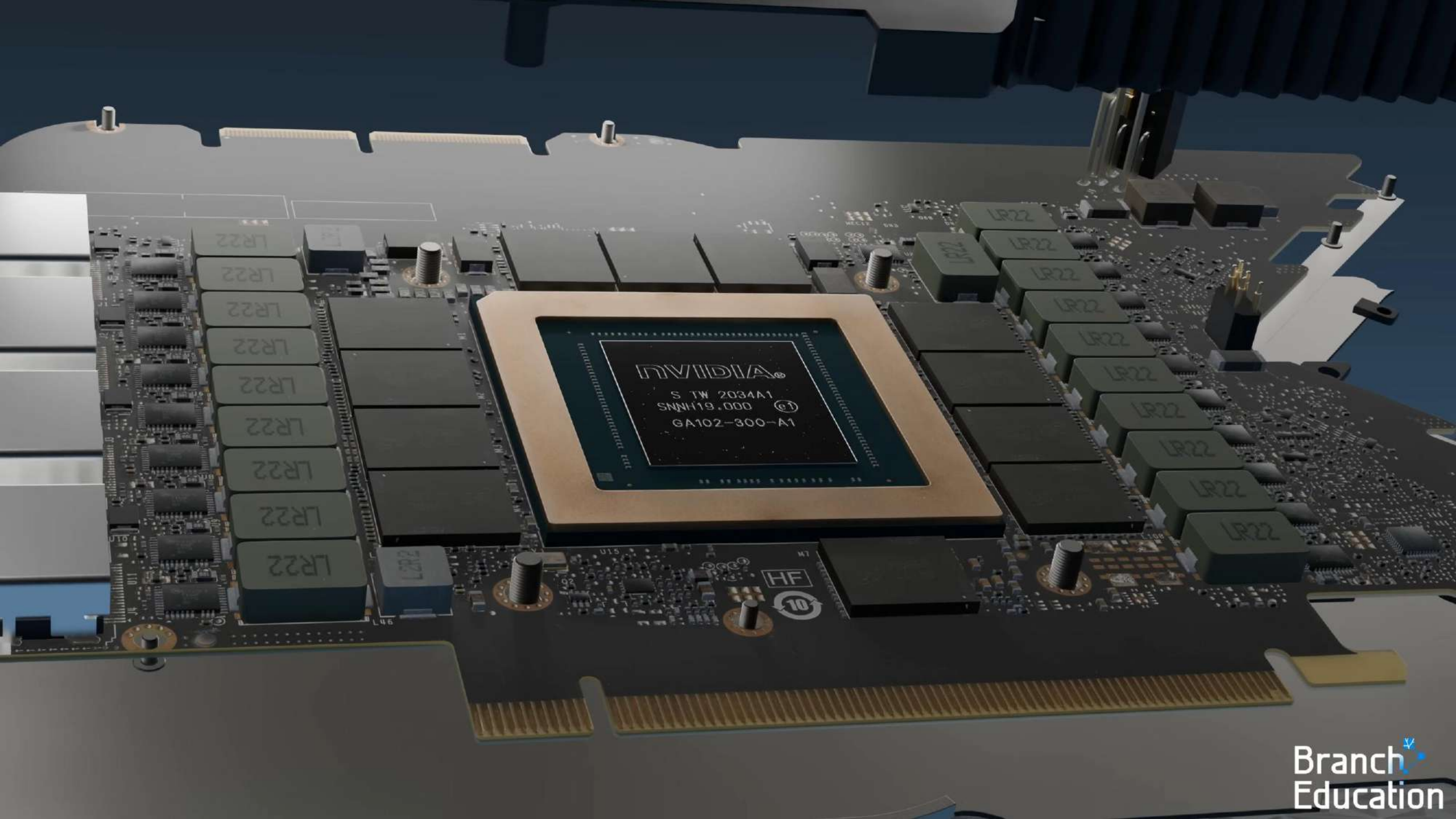

Branch
Education

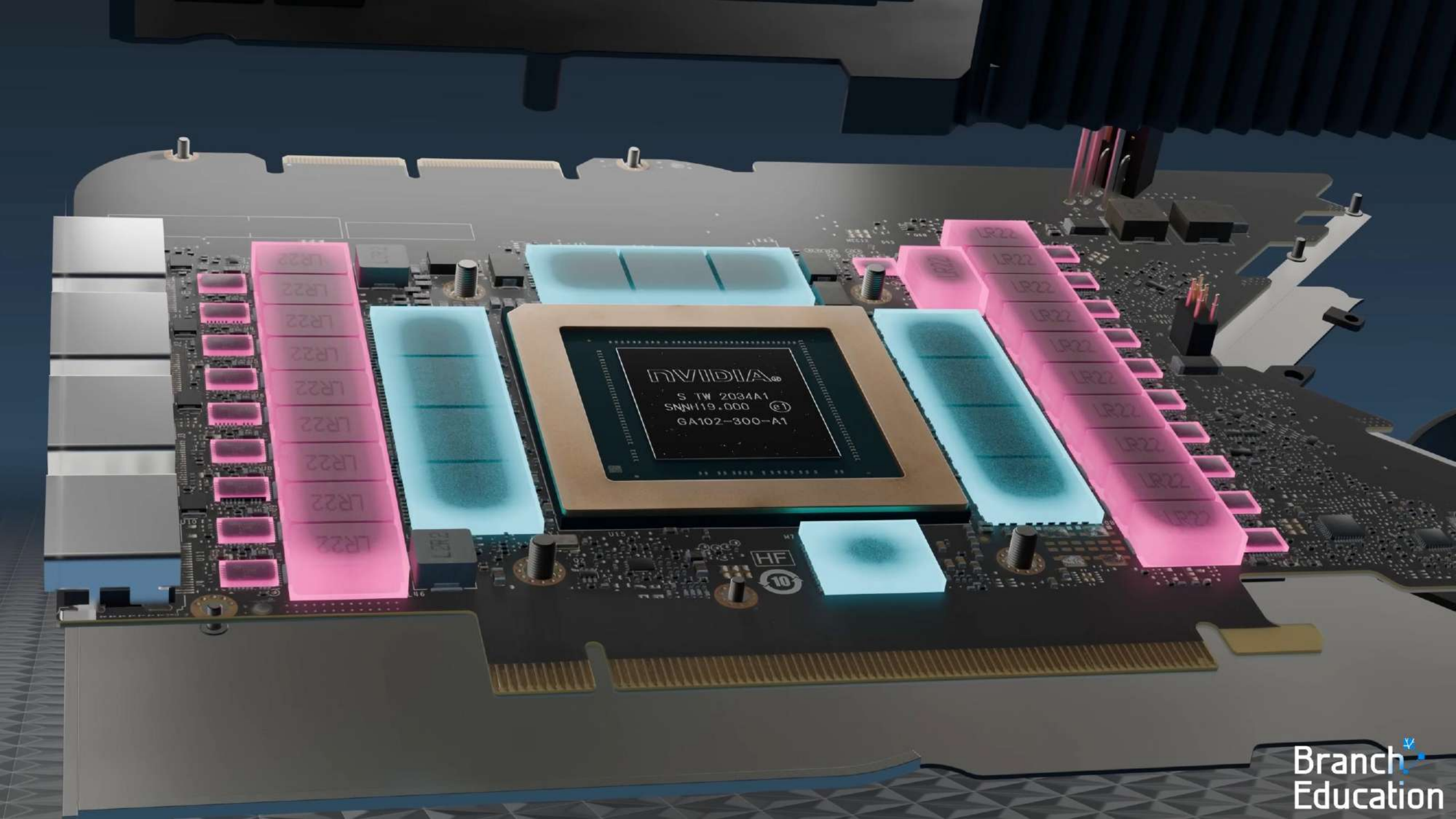
axb+c=d
C
1
0
.
+/-
>>
X
+
=
1 Multiply
1 Add
1 Clock Cycle
Branch
Education


2 Calculations
per core
x10496 Cores
x1.7 Ghz
axb+c=d
C
1
0
.
+/-
>>
x
+
=
Branch
Education

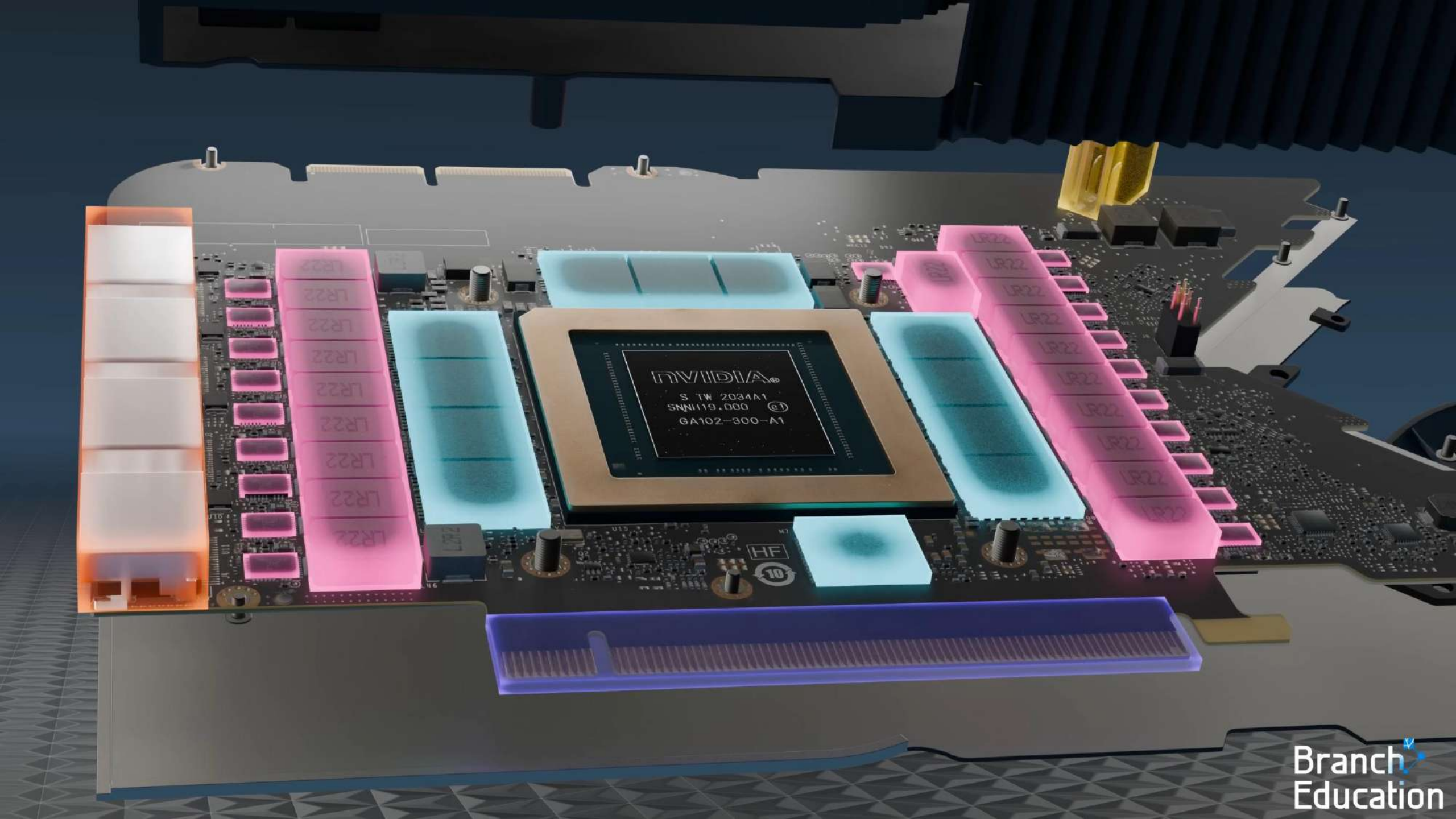

2 Calculations
per core
x 10496 Cores
x 1.7 Ghz
35.6 Trillion Calculations
per second
axb+c=d
C
1
0
.
+/-
>>
x
+
=
Branch
Education


NVLink
Graphic Memory Controller
Graphic Memory Controller
Graphic Memory Controller
Graphic Memory Controller
Graphic Memory Controller
Graphic Memory Controller
L2 Cache
Gigathread Engine
L2 Cache
PCIe Interface
Branch Education

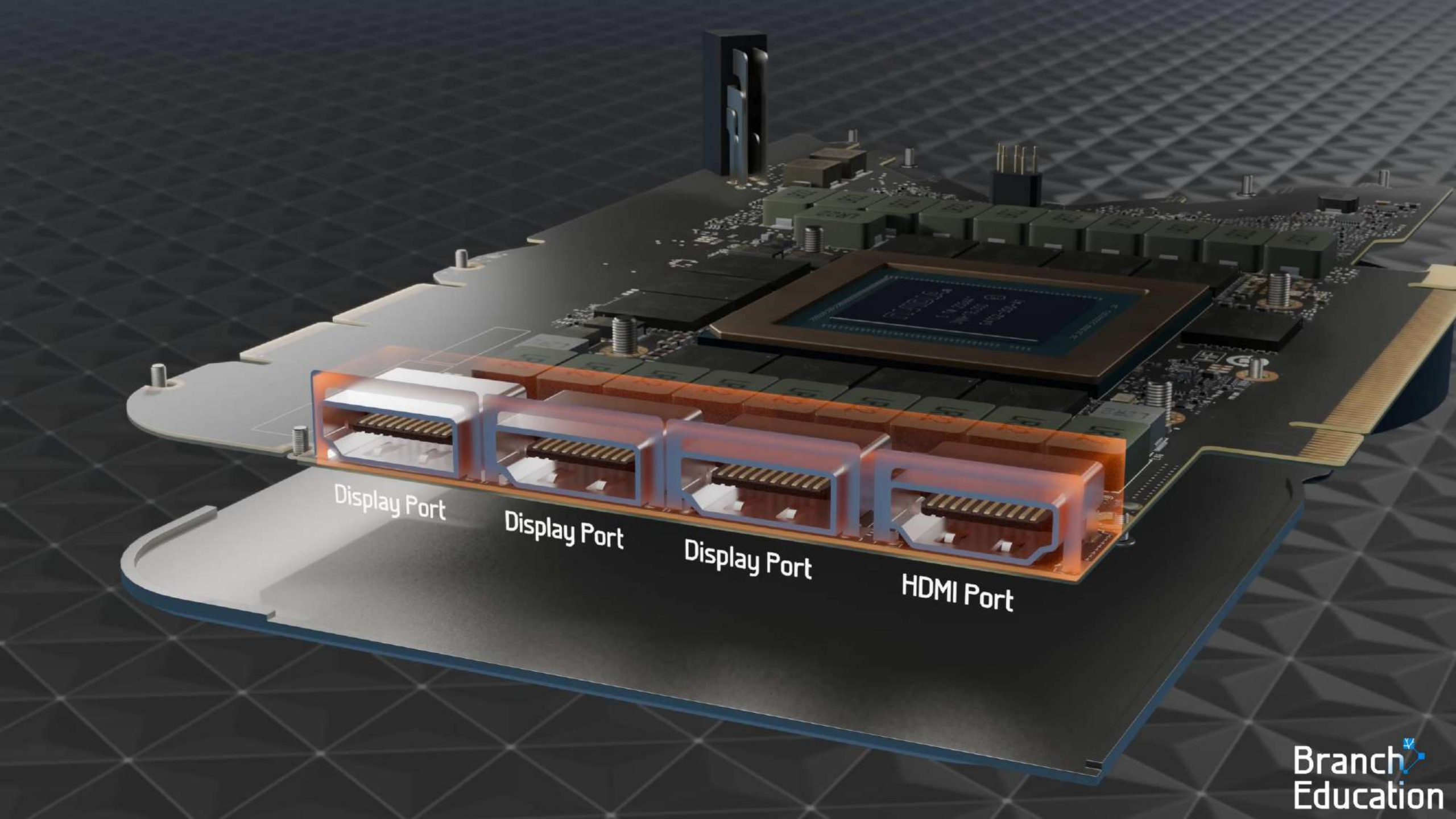

NVIDIA
S TW 2034A1
SNNH19.000
GA102-300-A1
HF
LR22
Branch
Education

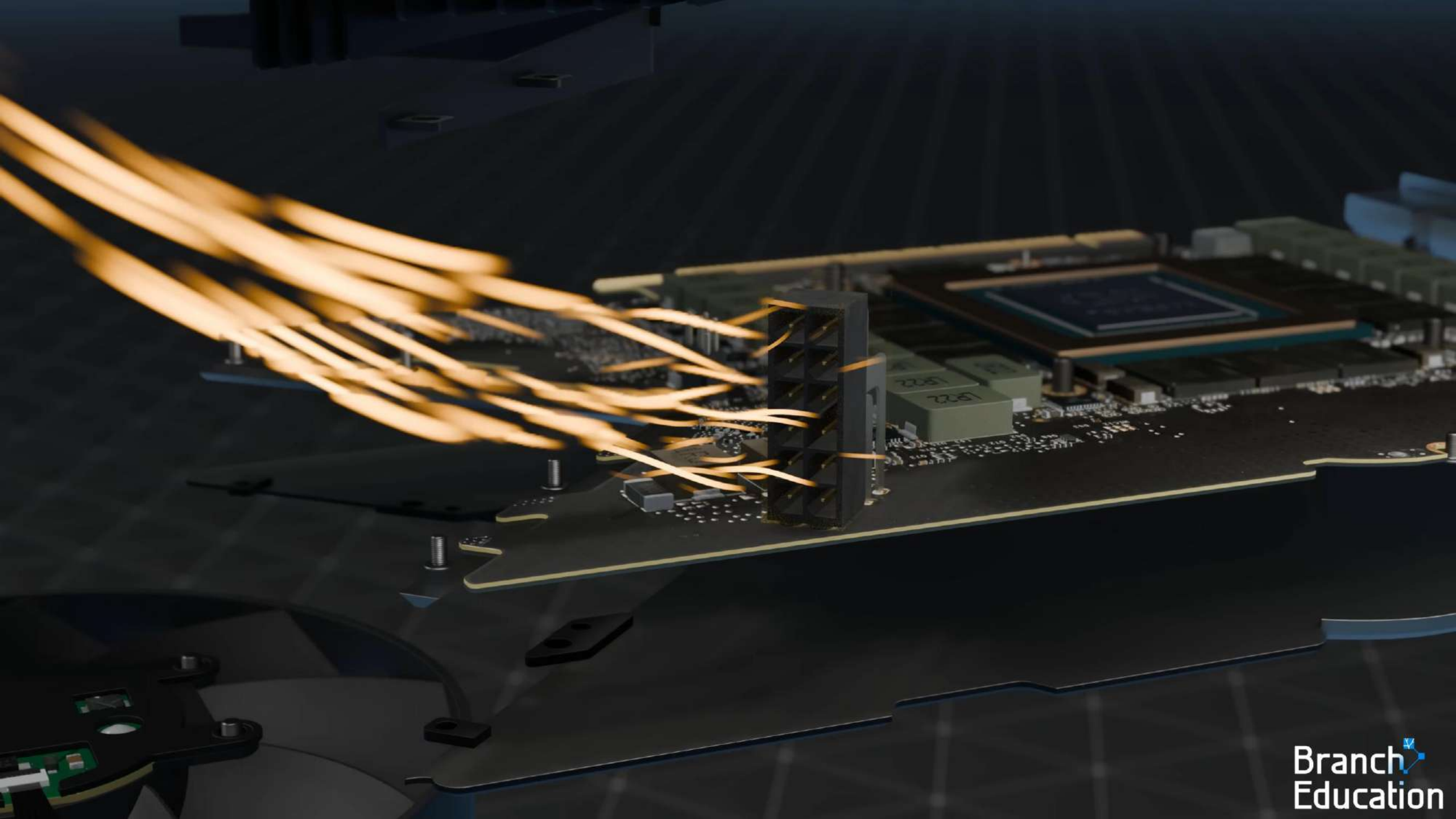


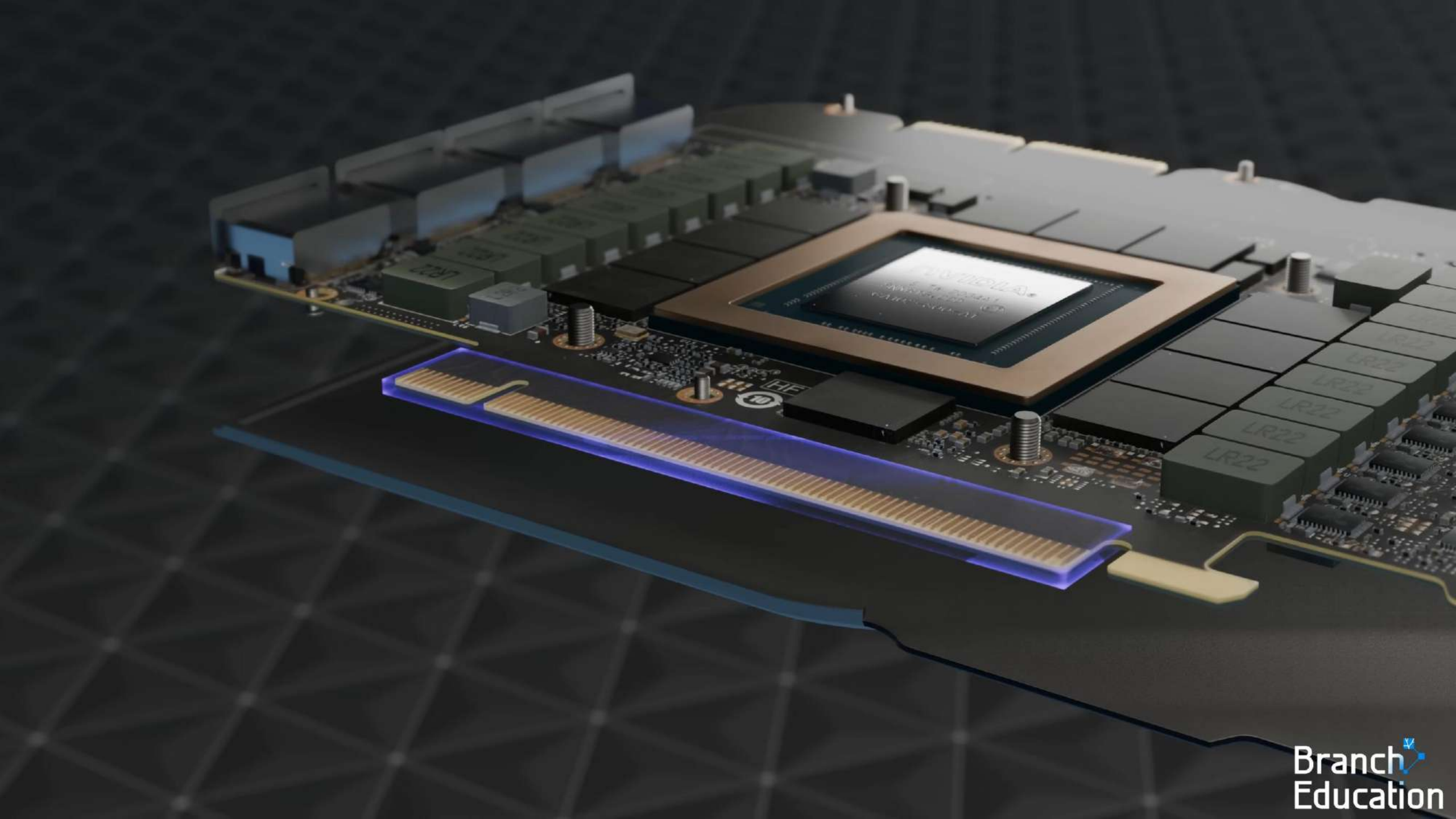
Branch Education

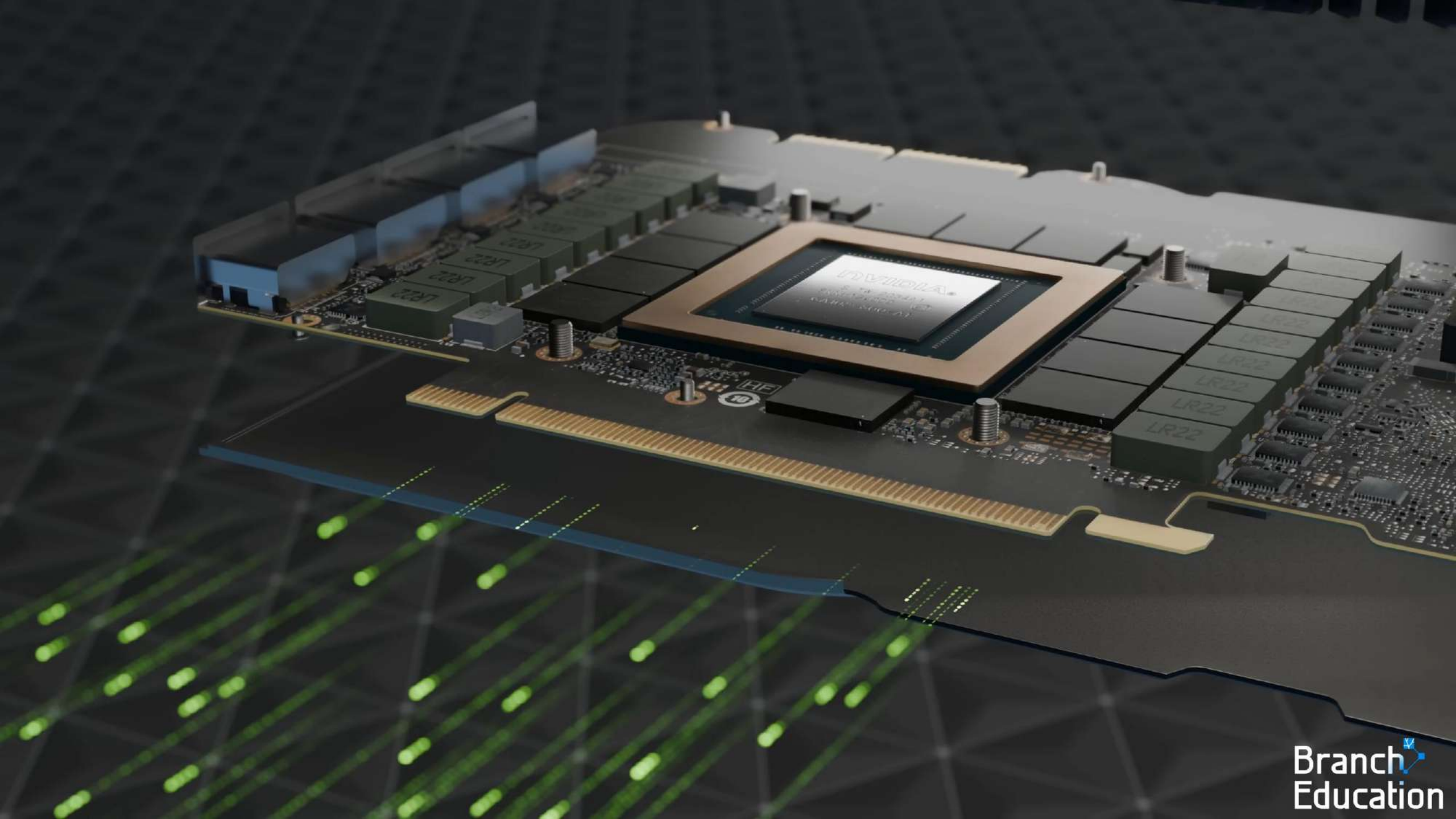


Branch Education


Display Port
Display Port
Display Port
HDMI Port
Branch Education

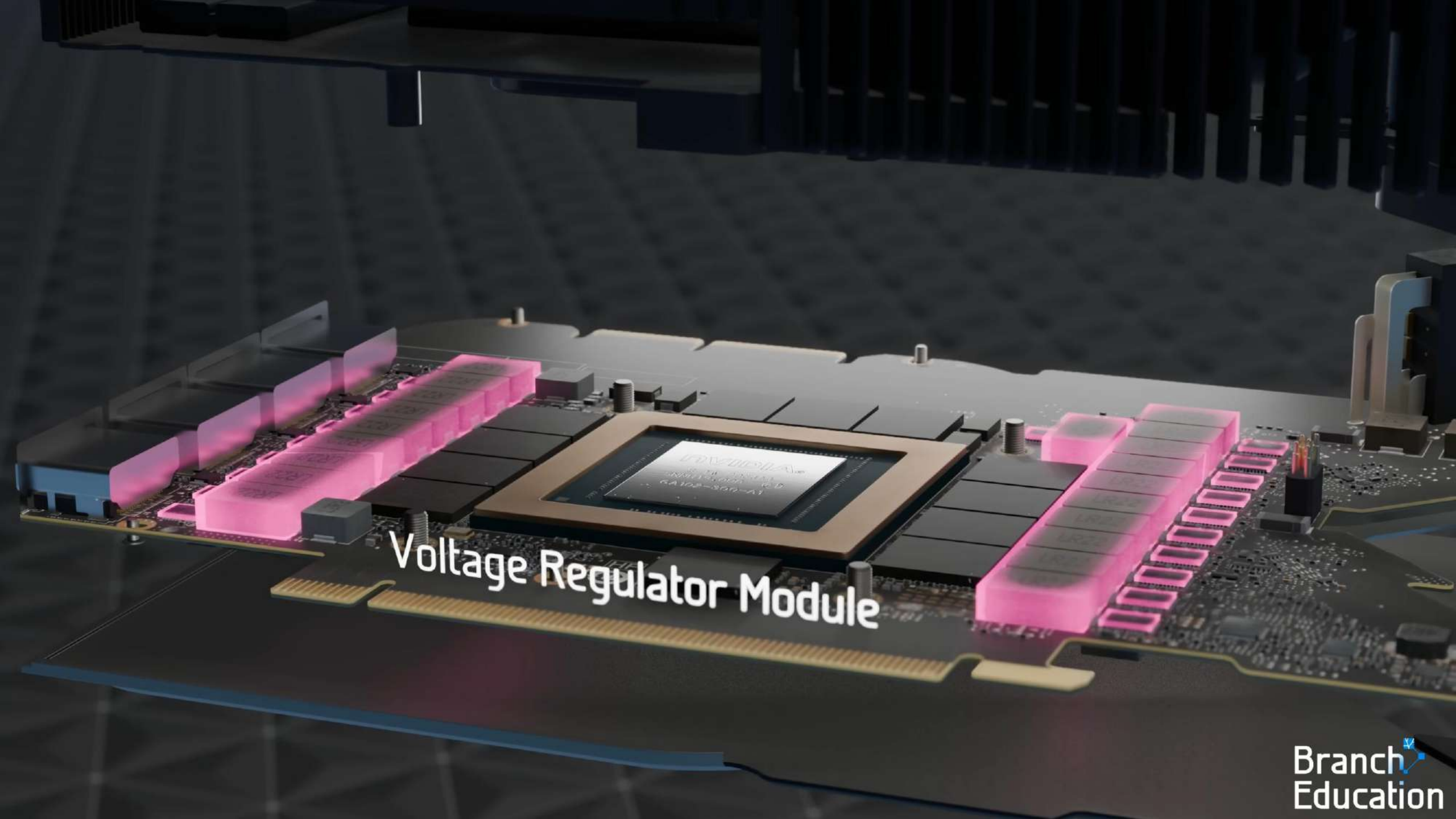

Branch
Education

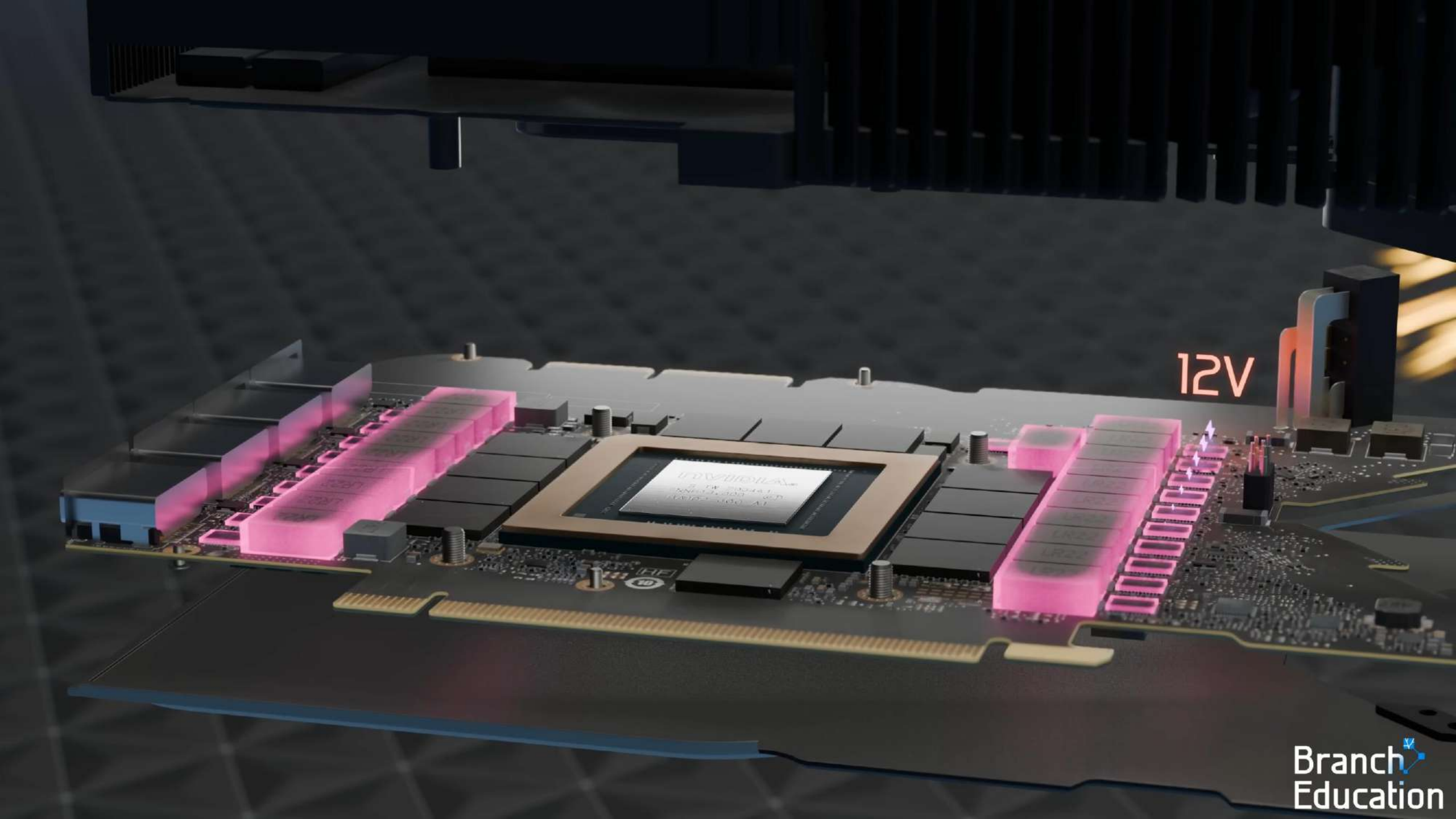

LR22
Branch
Education

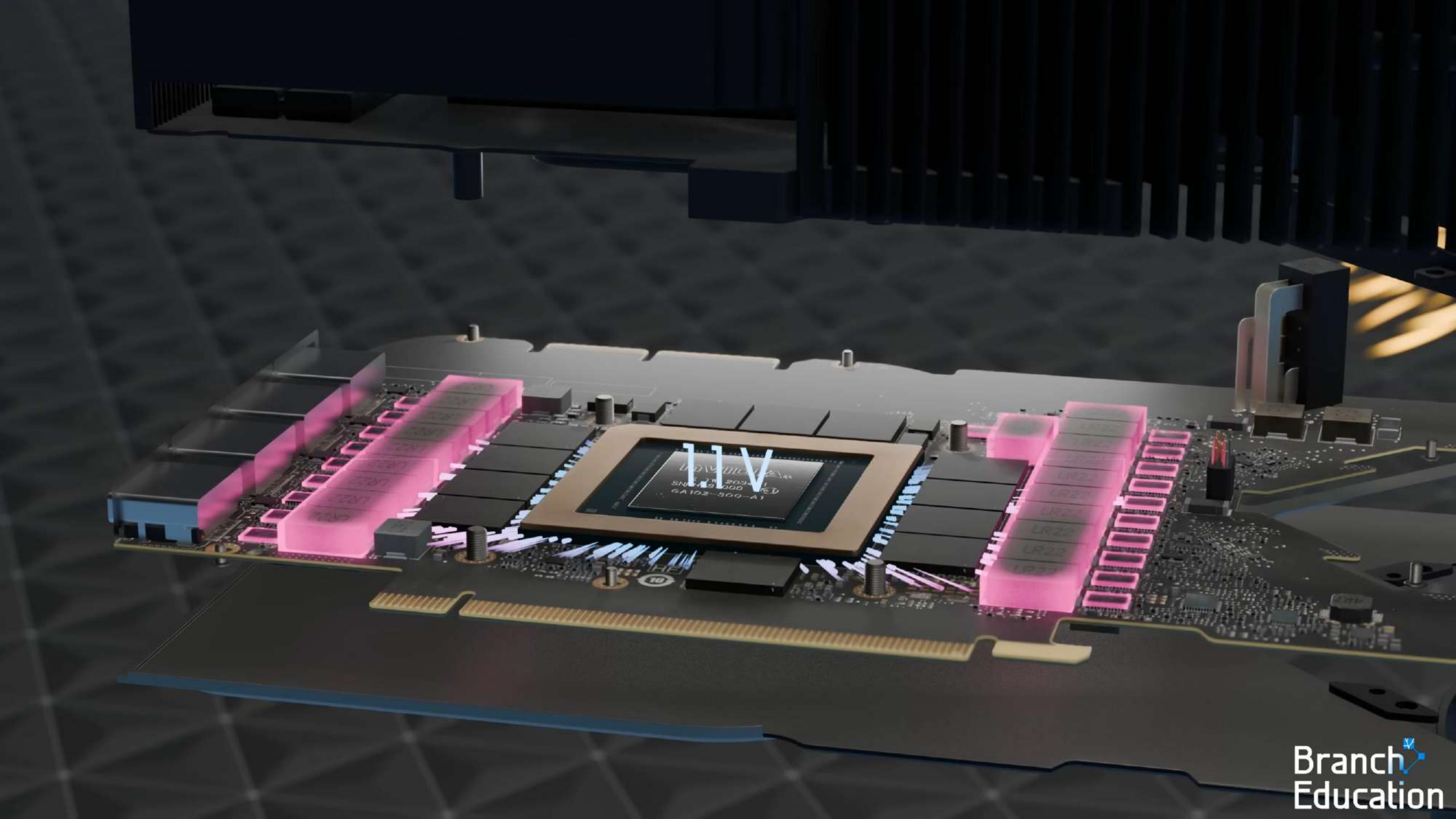

Branch
Education

VRM과 전원부 (식사량 조절 담당)

- 고성능 GPU는 300W 이상 소비 → 안정적인 전압 필요
- 여러 개의 페이즈로 나눠서 전류 공급

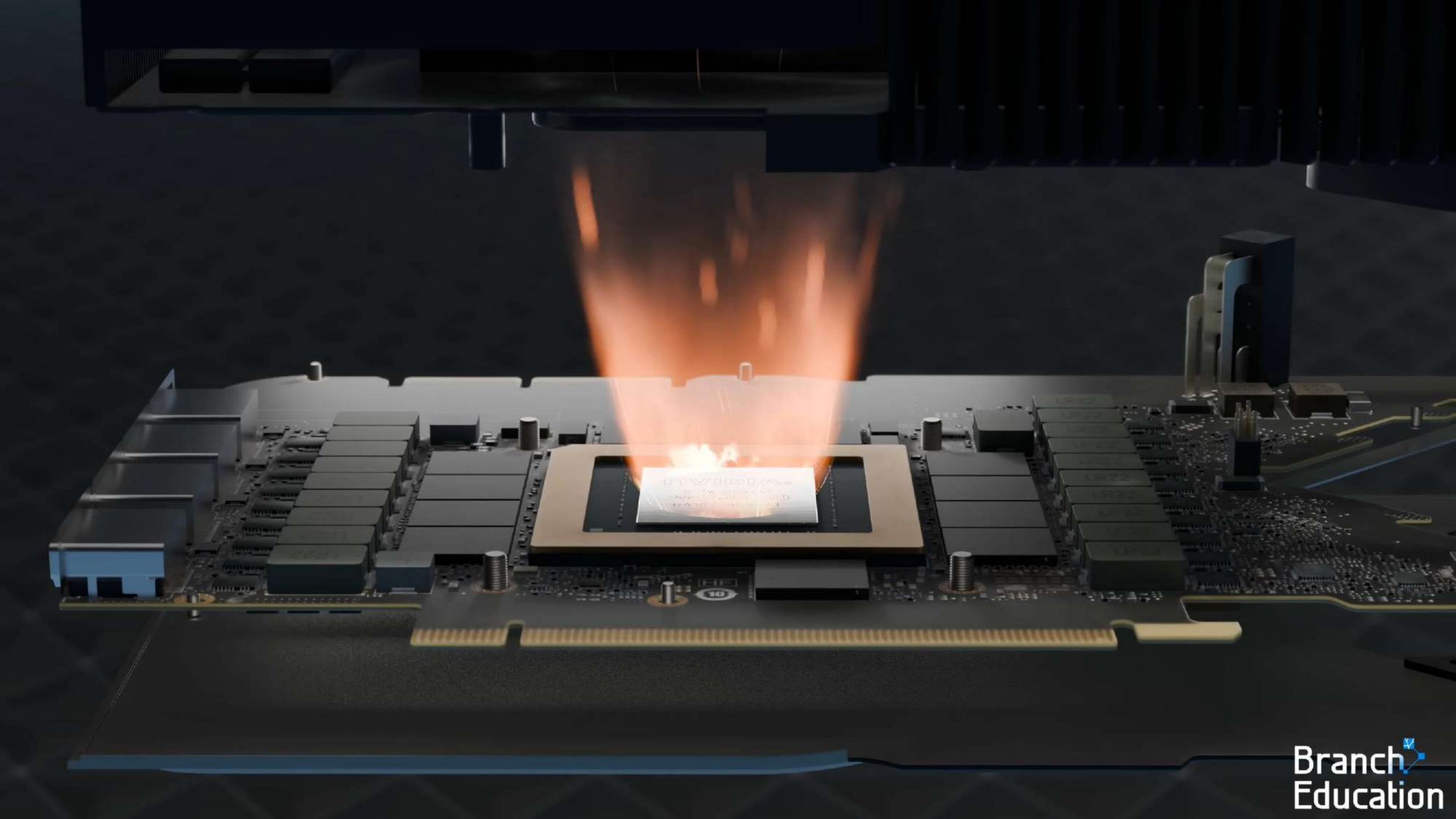

Voltage Regulator Module
Branch Education

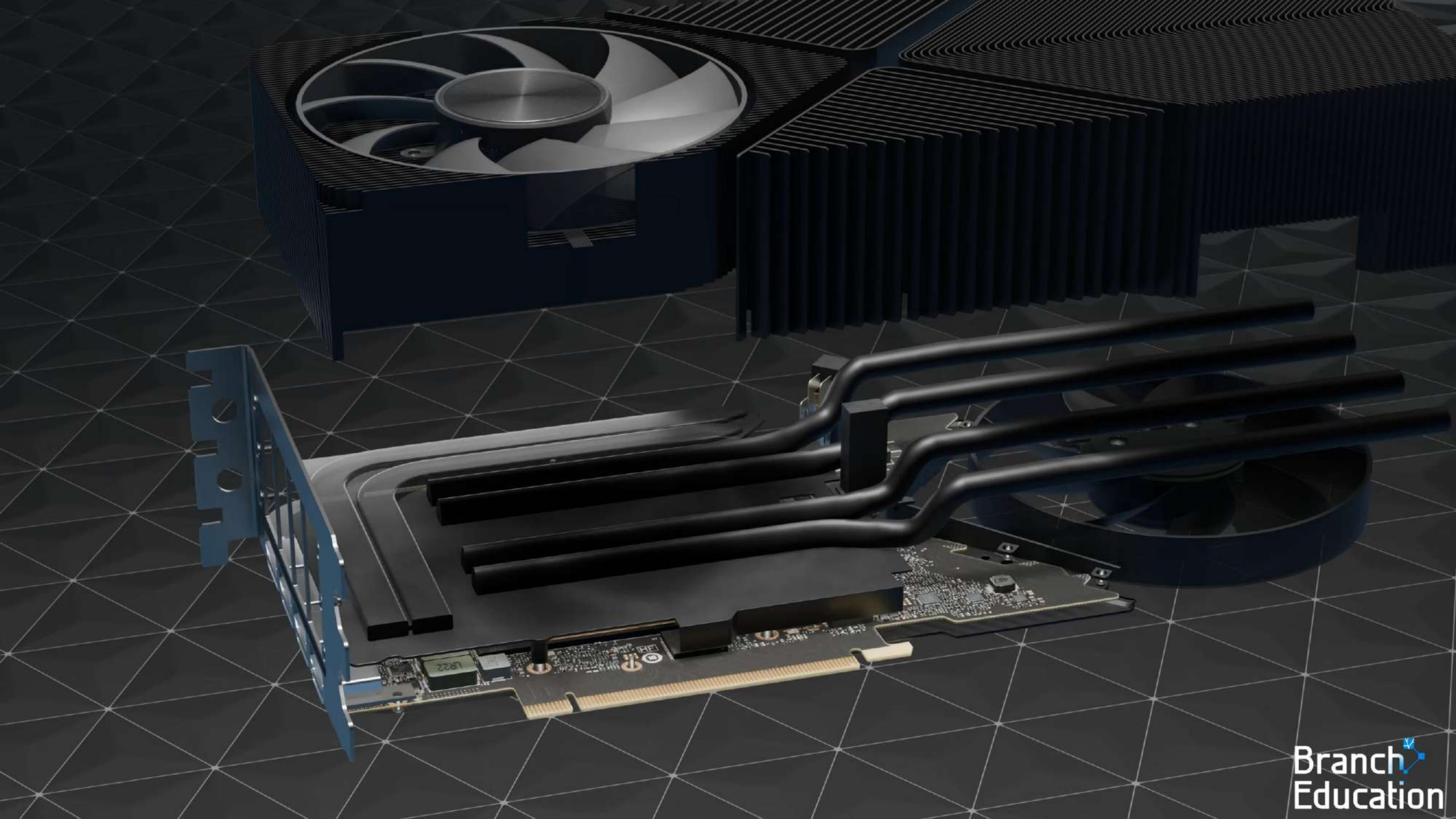

12V
Branch
Education

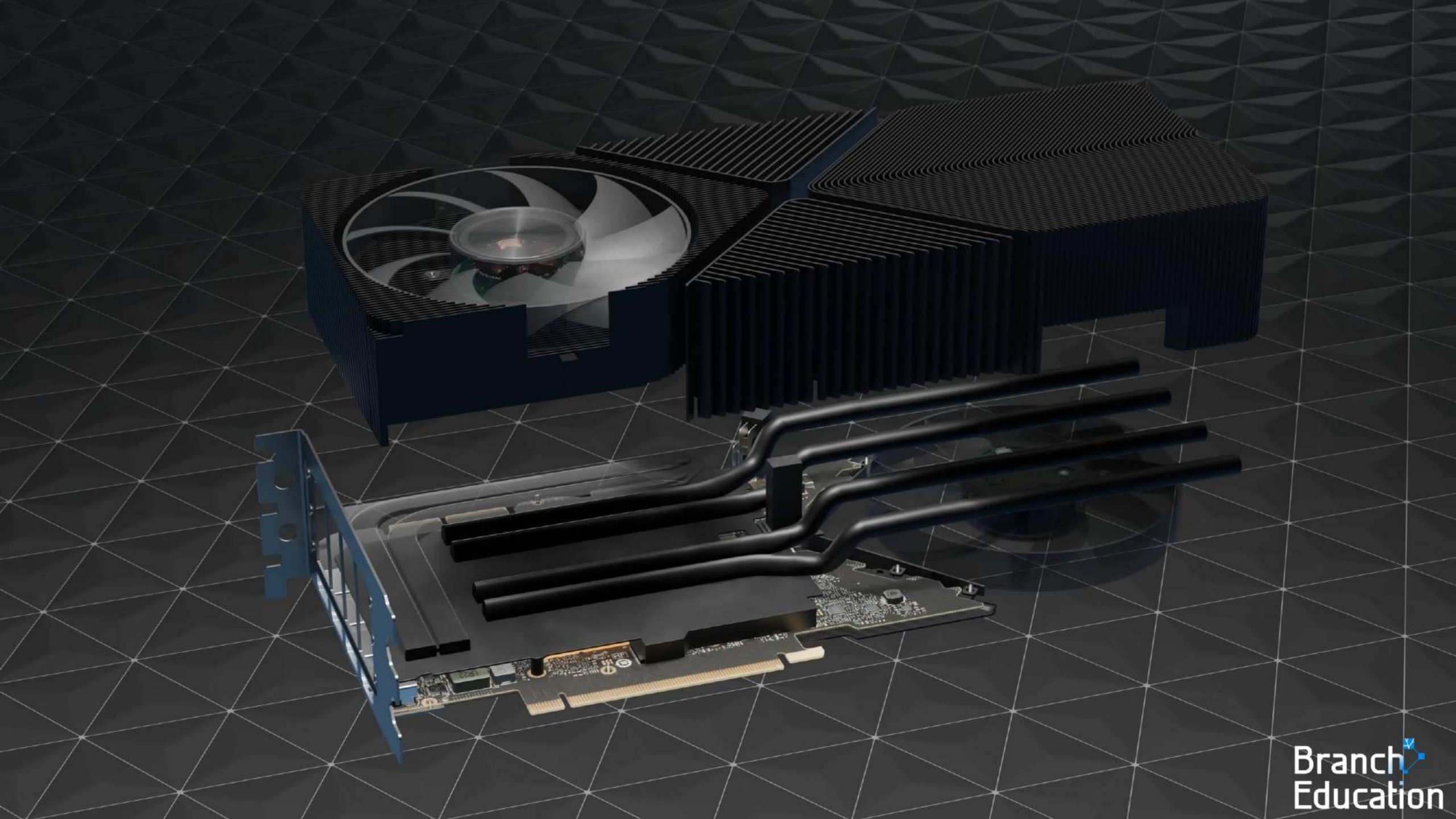

11V
GA102-300-A1
Branch
Education

쿨링 시스템

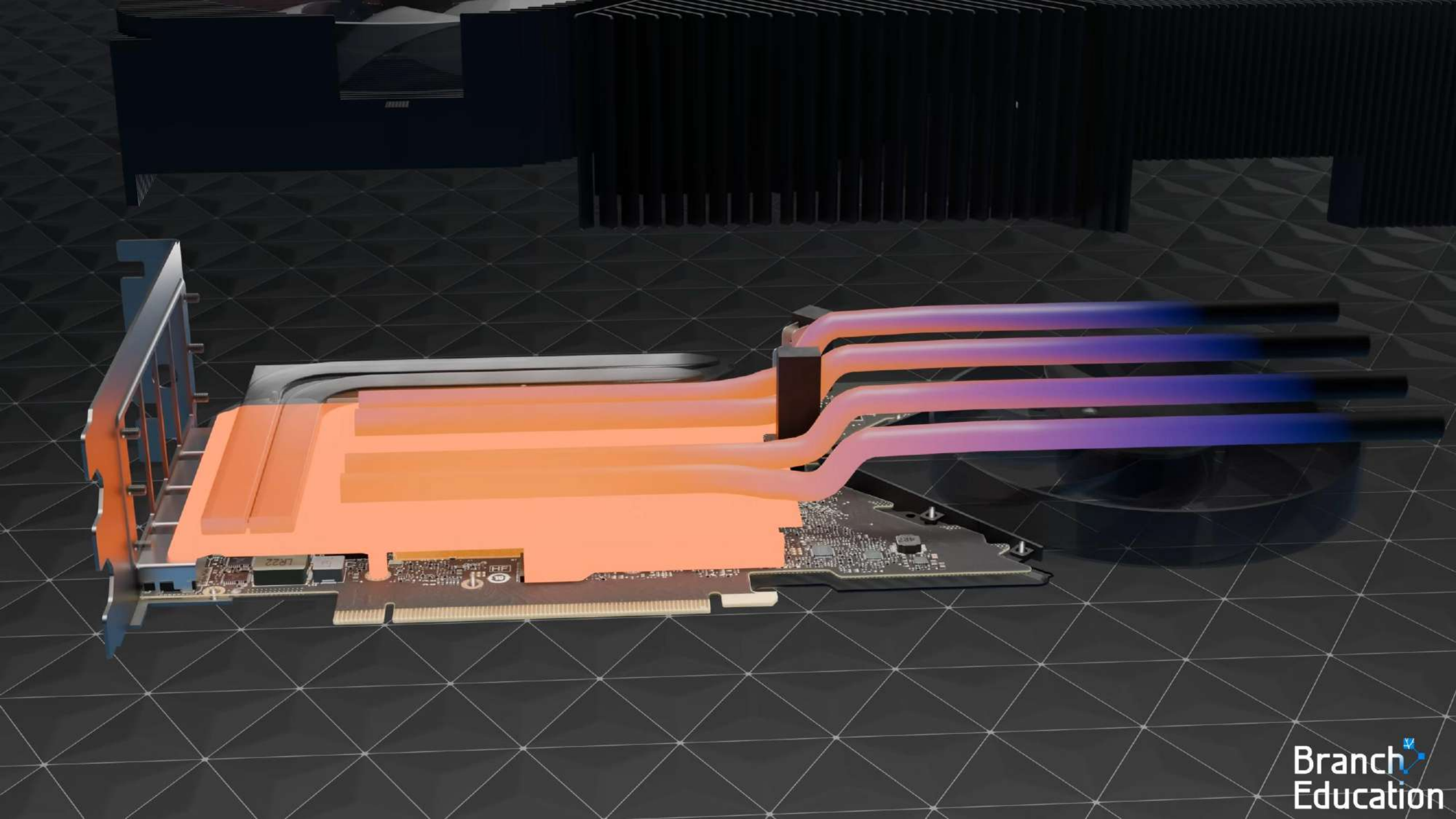
- 3팬, 히트파이프, 알루미늄 방열판
- 고온 방지 위해 매우 정교한 설계

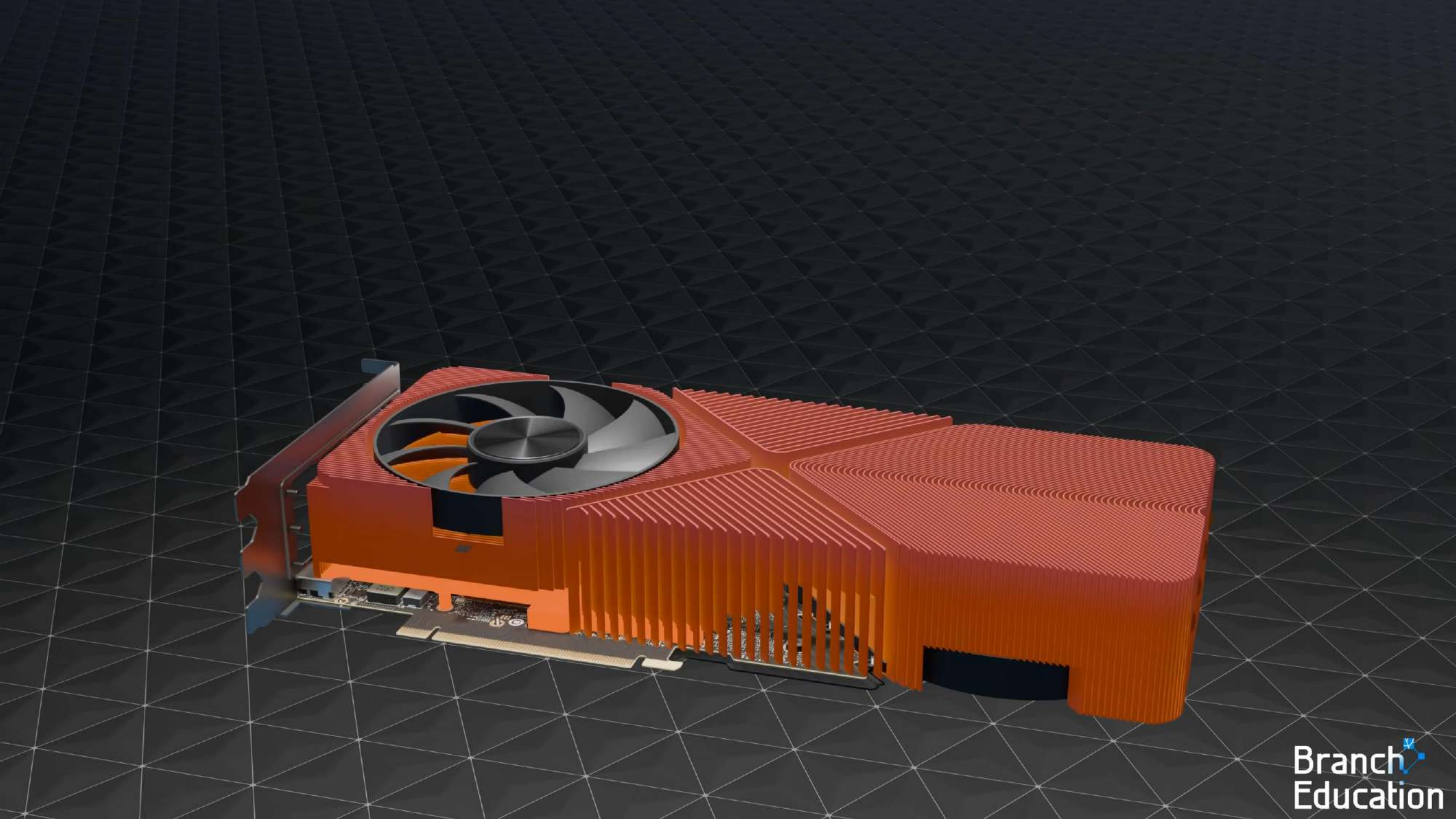

Branch
Education

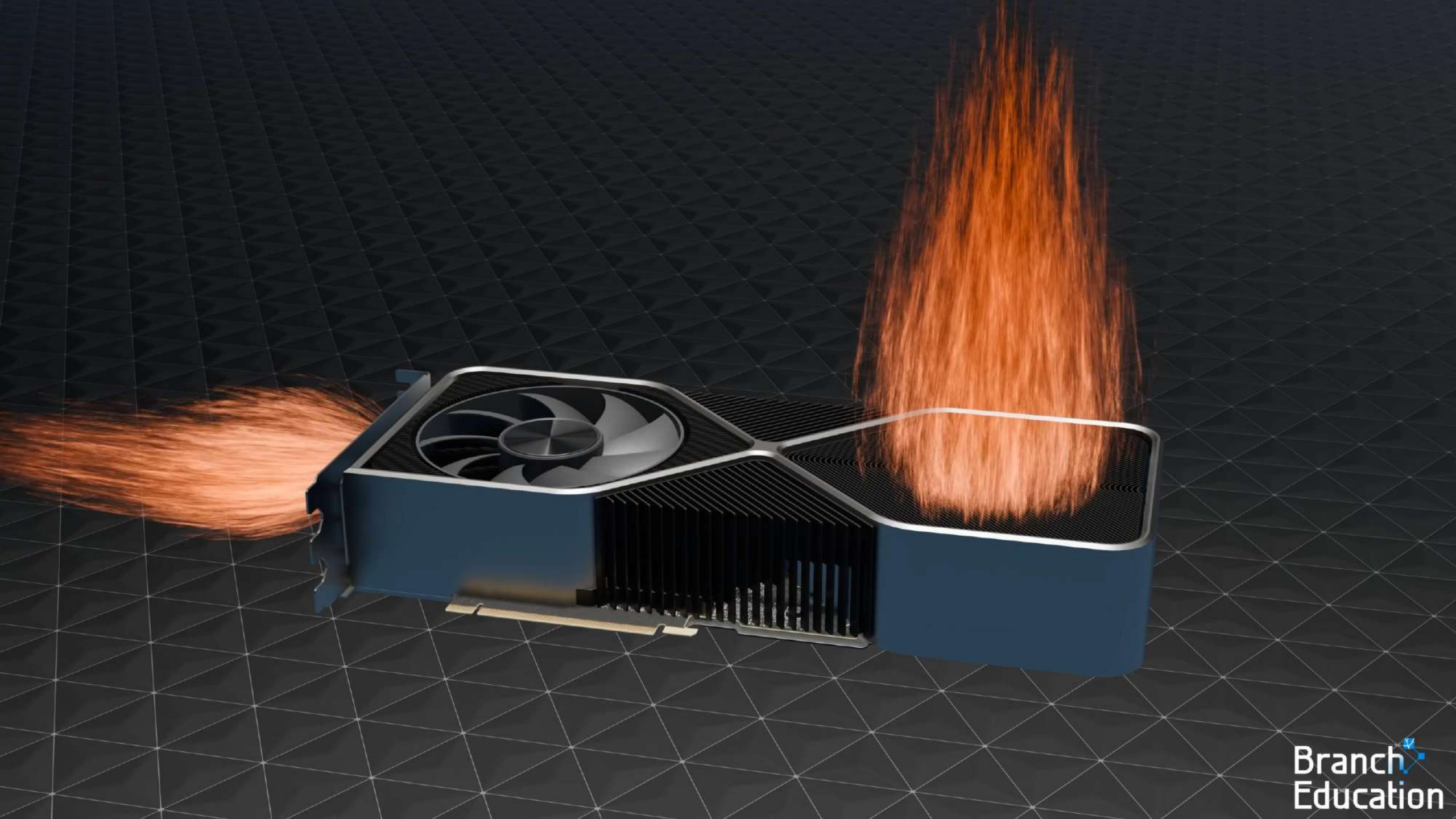

Branch
Education


Branch
Education

Branch
Education

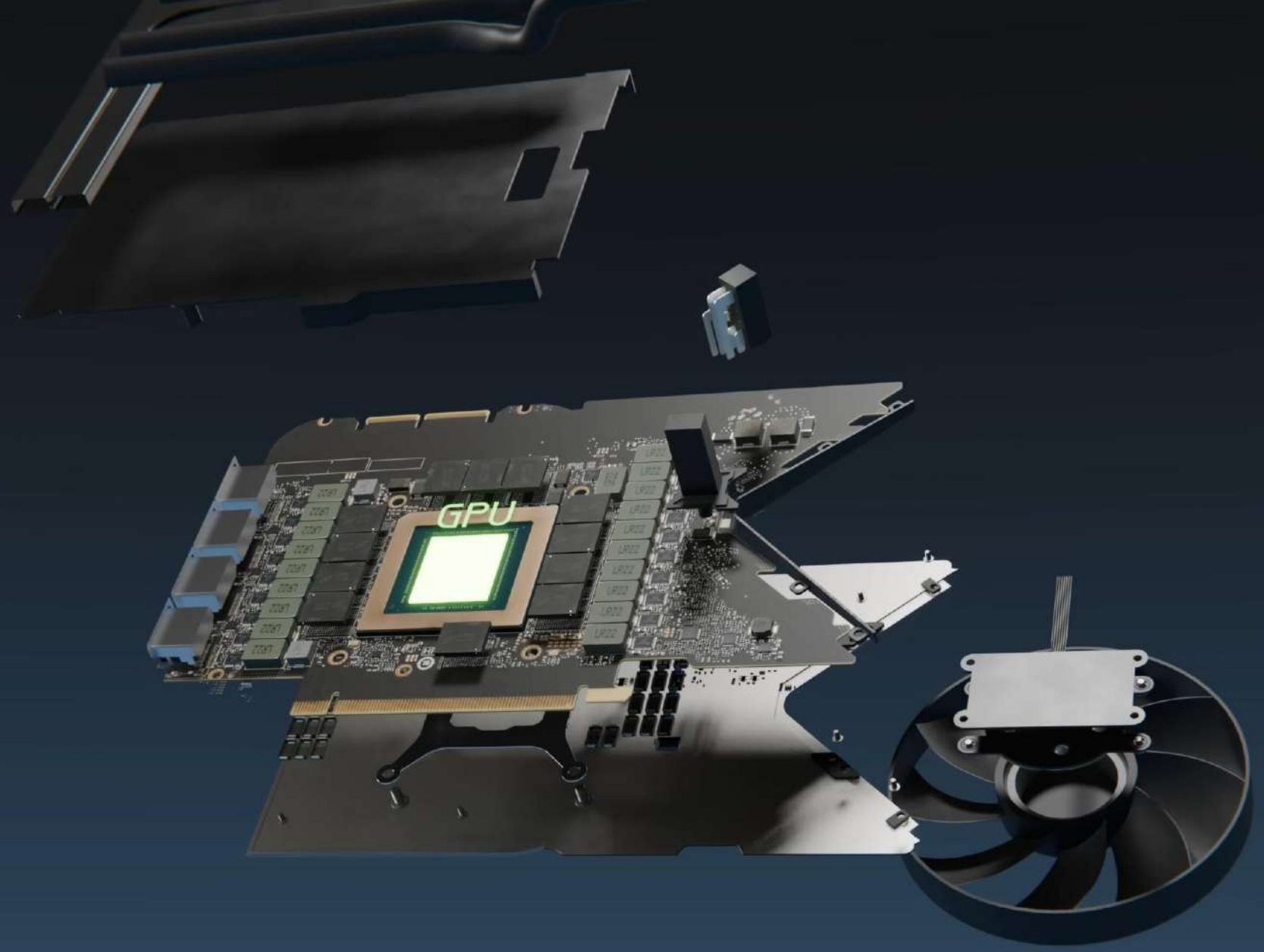

Branch
Education


Branch
Education

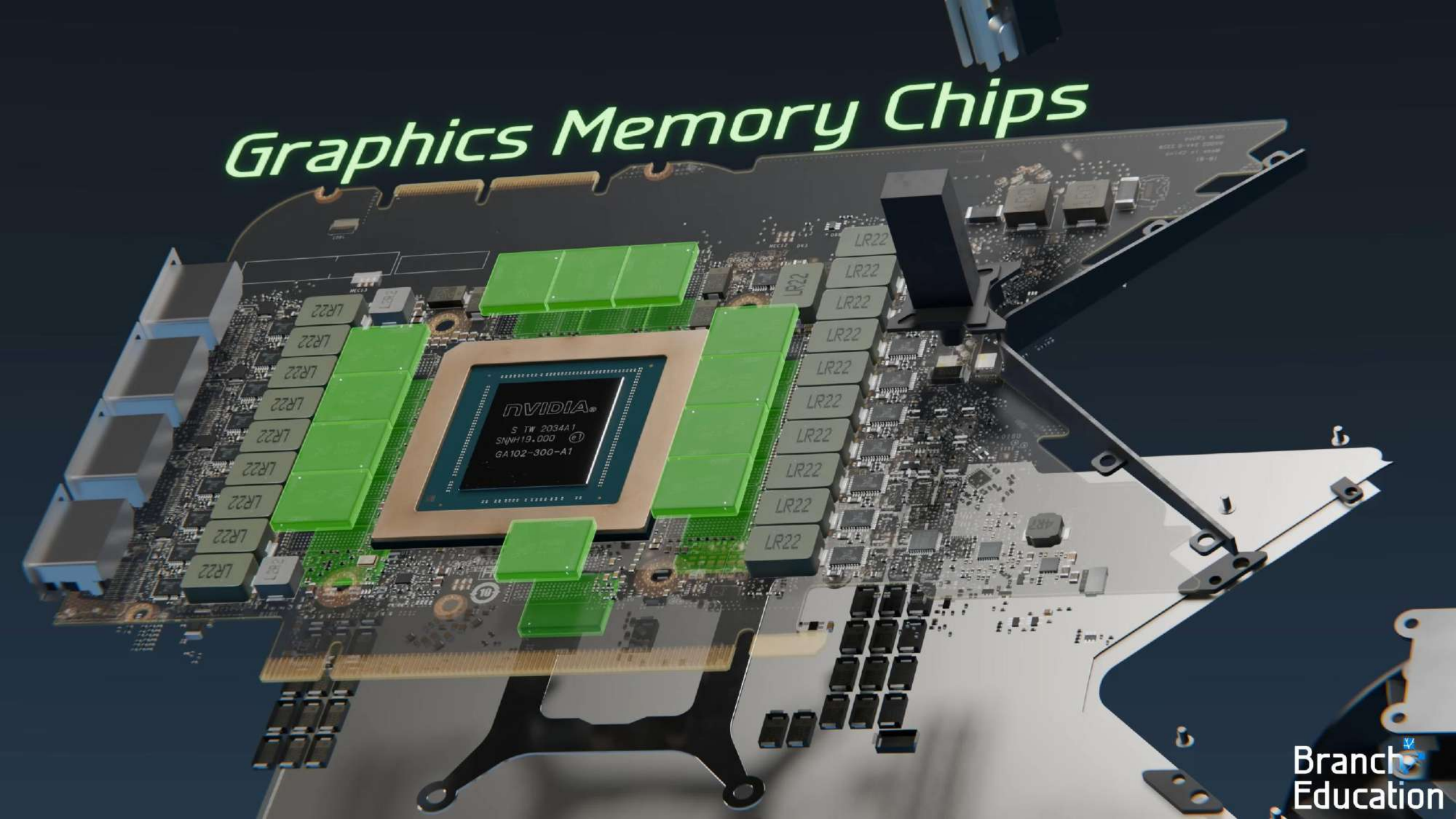

Branch
Education

GDDR6X VRAM

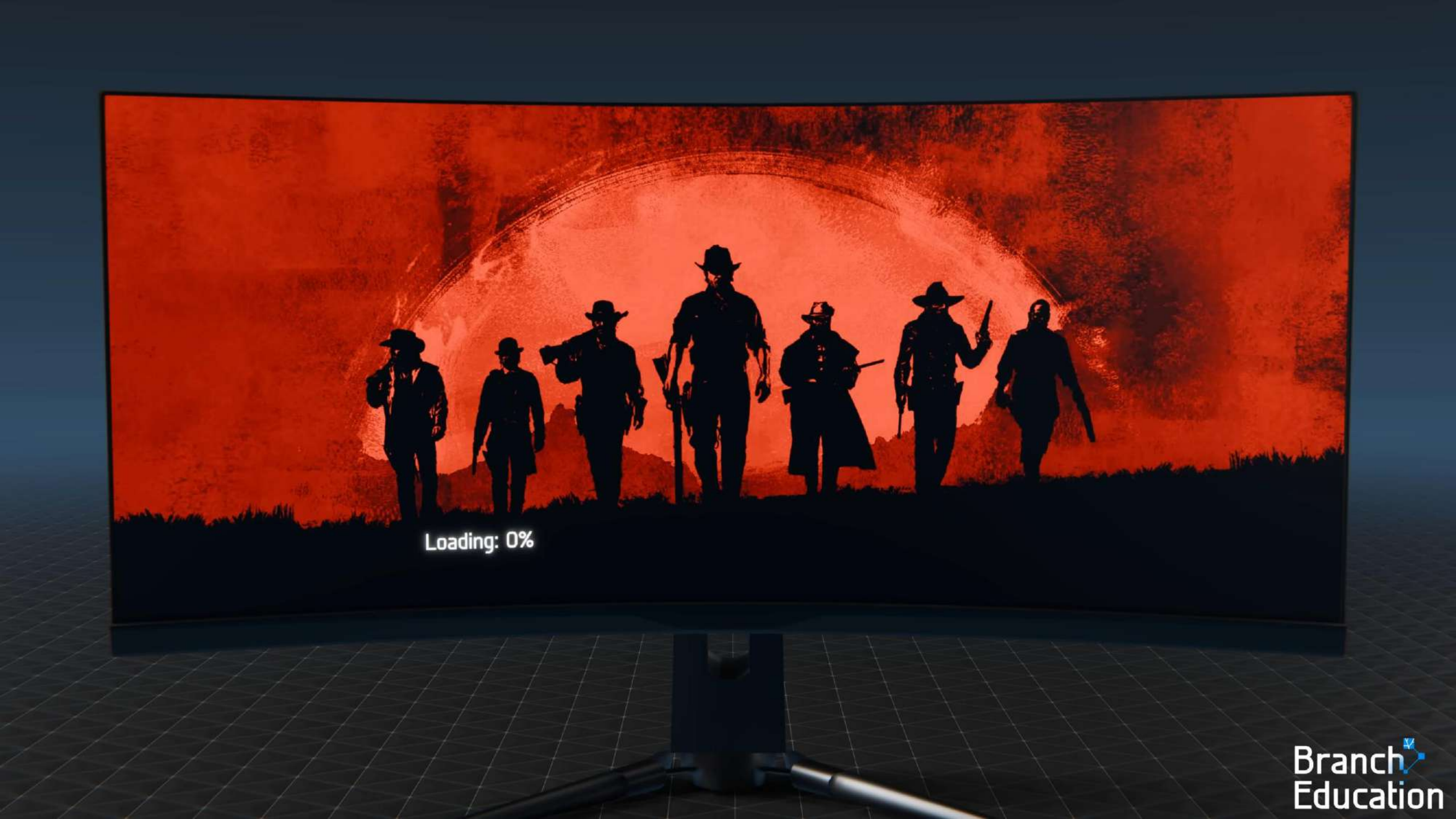
- 912GB/s ~ 1TB/s급 대역폭
- PAM4 기술로 클럭당 2비트 전송



Branch Education

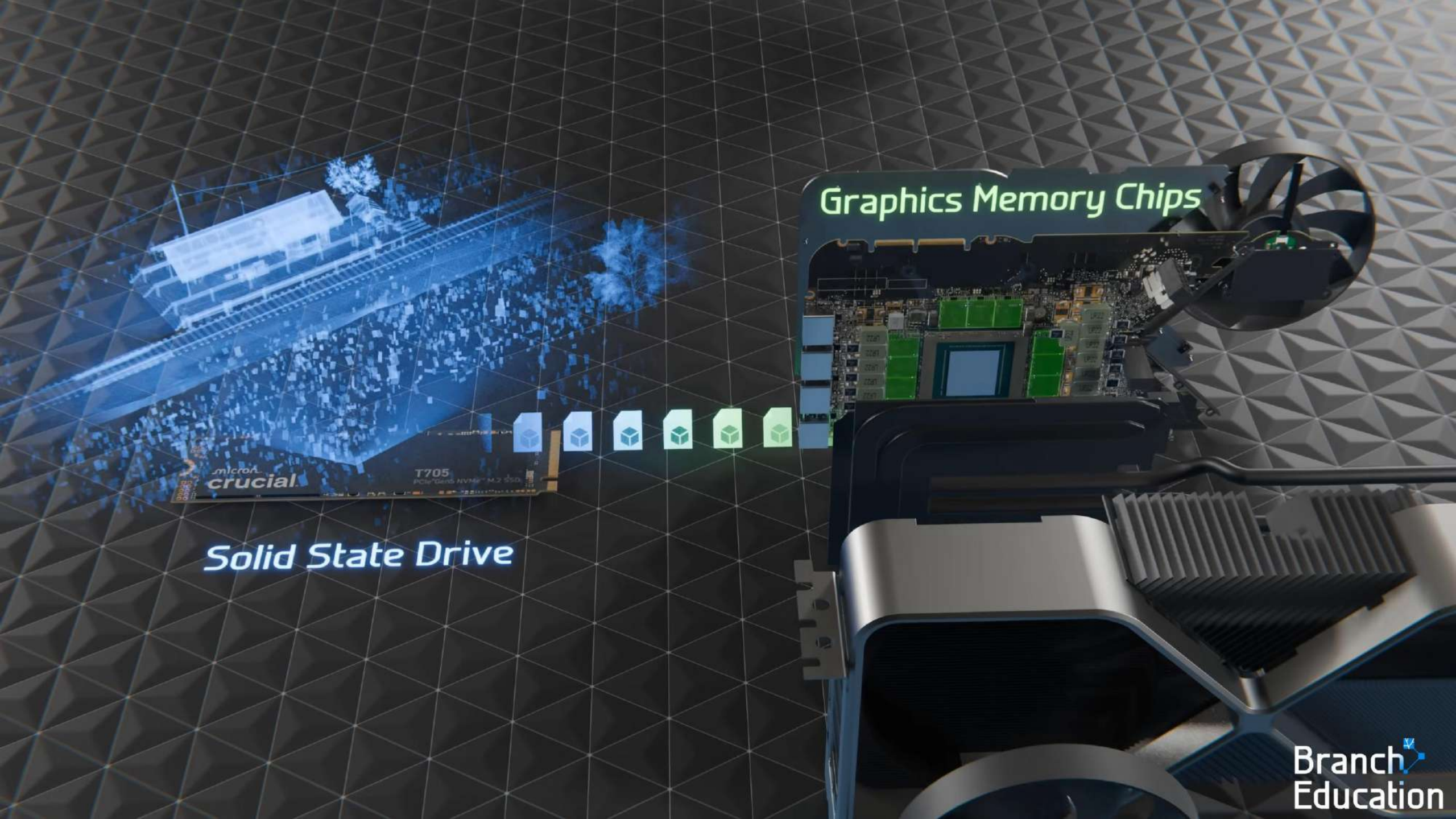

Graphics Memory Chips
NVIDIA
S TW 2034A1
SNNH19.000
GA102-300-A1
LR22
Branch Education

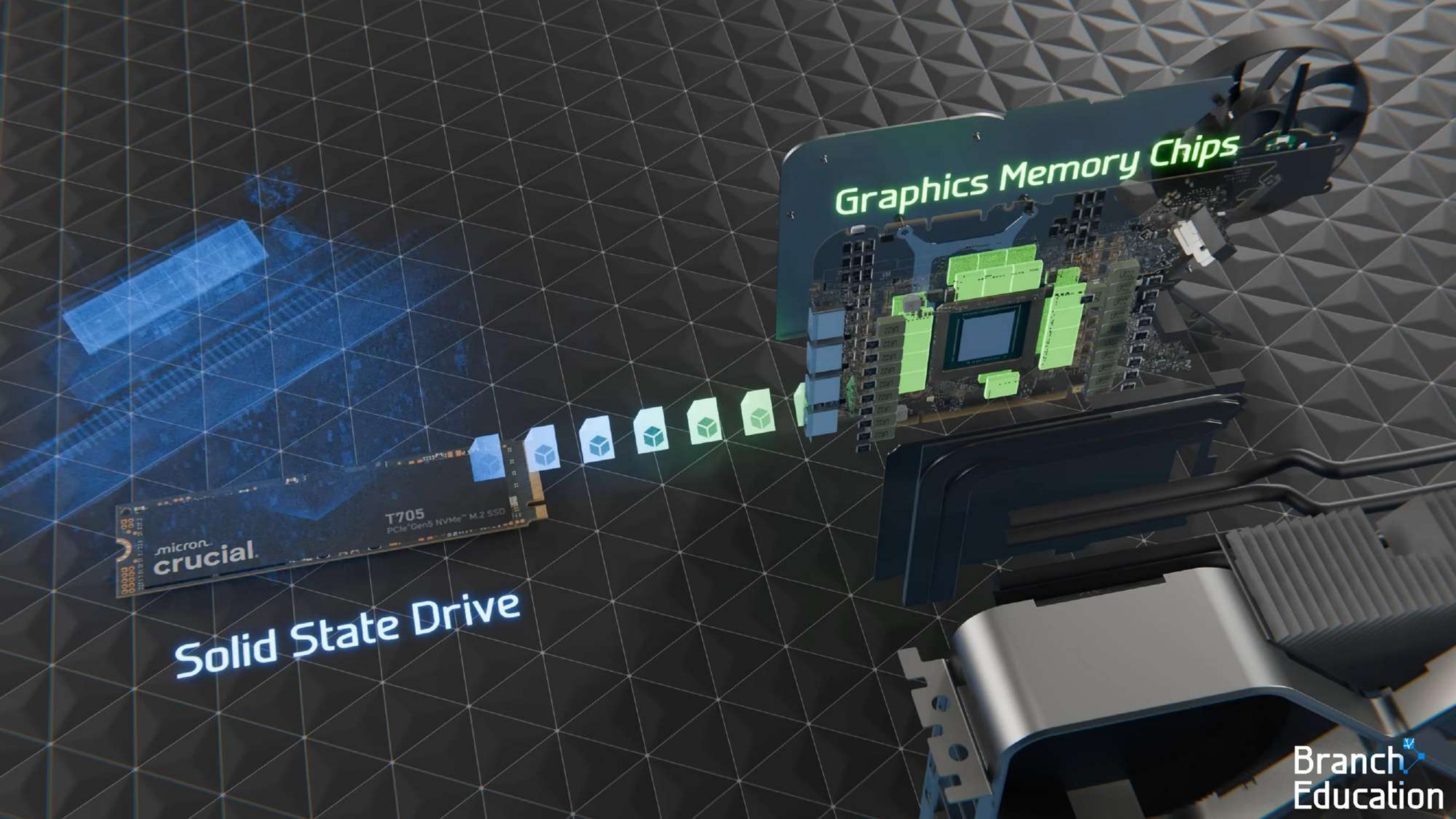
GDDR6X
SDRAM
GDDR6X
SDRAM
GDDR6X
SDRAM
GDDR6X
SDRAM
LR22
LR22
LR22
LR22
LR22
LR22
LR22
Branch
Education

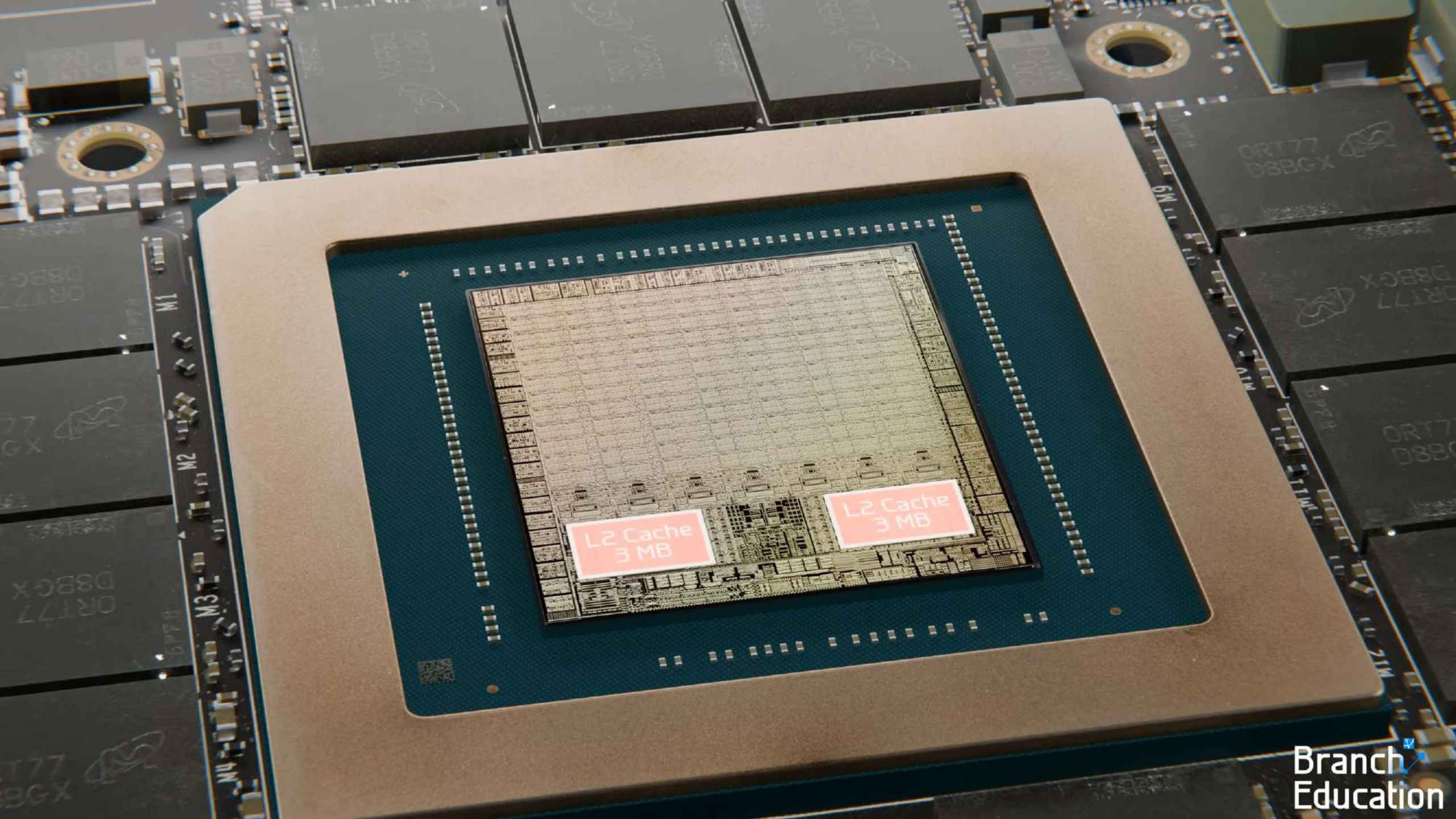

Loading: 0%
Branch
Education

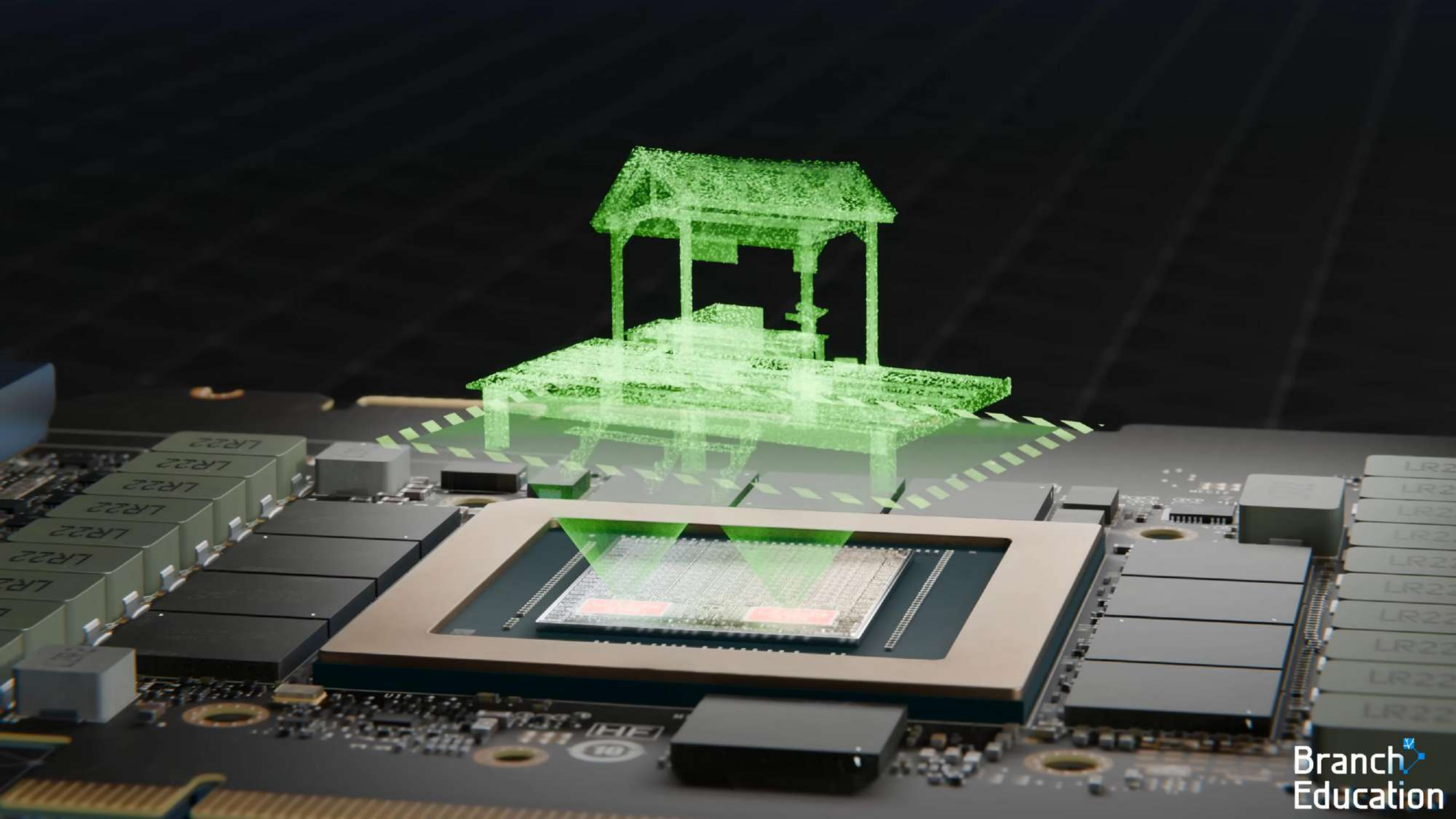
Loading: 55%
crucial
Branch
Education

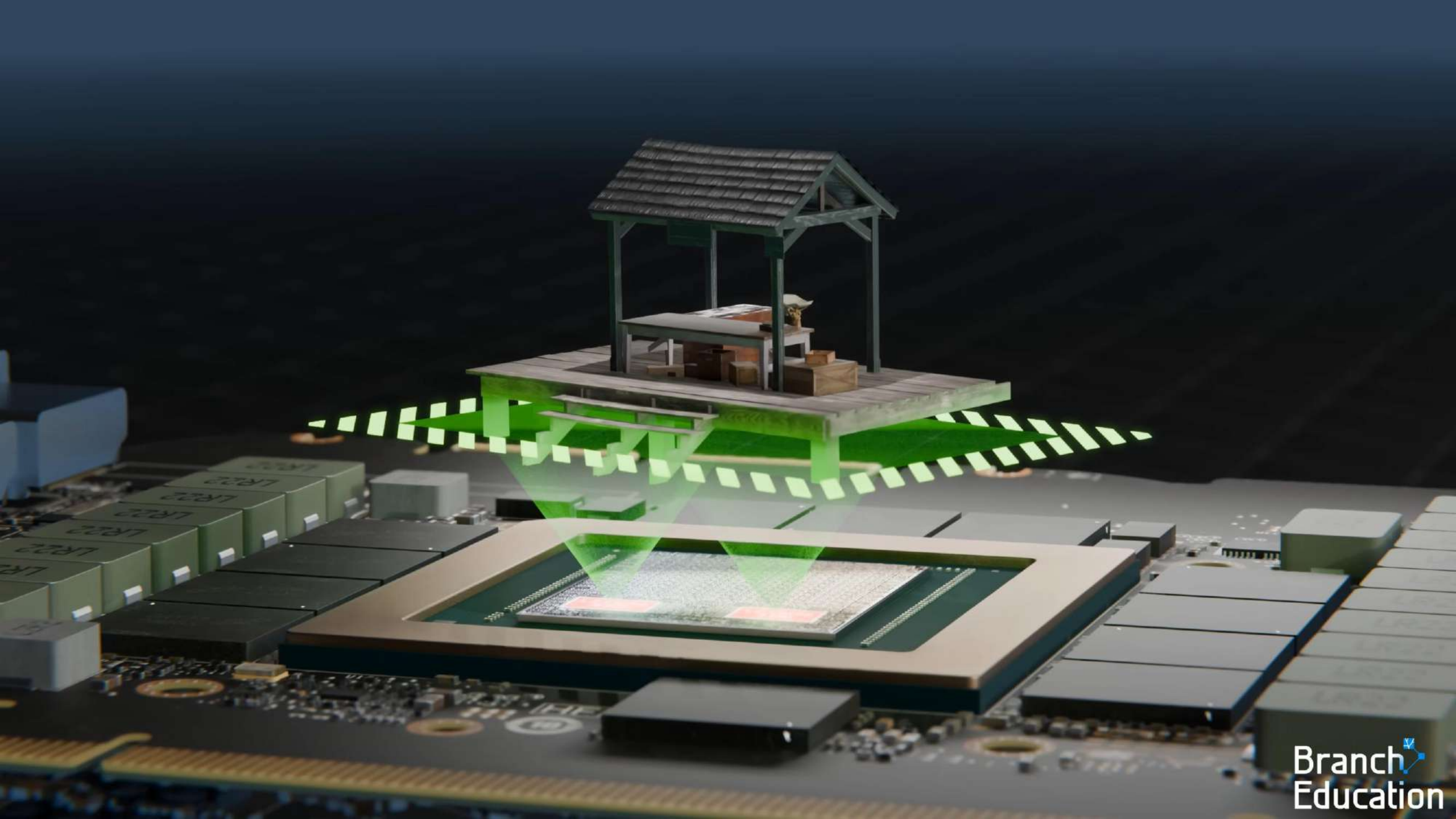
Loading: 80%
crucial
Branch Education

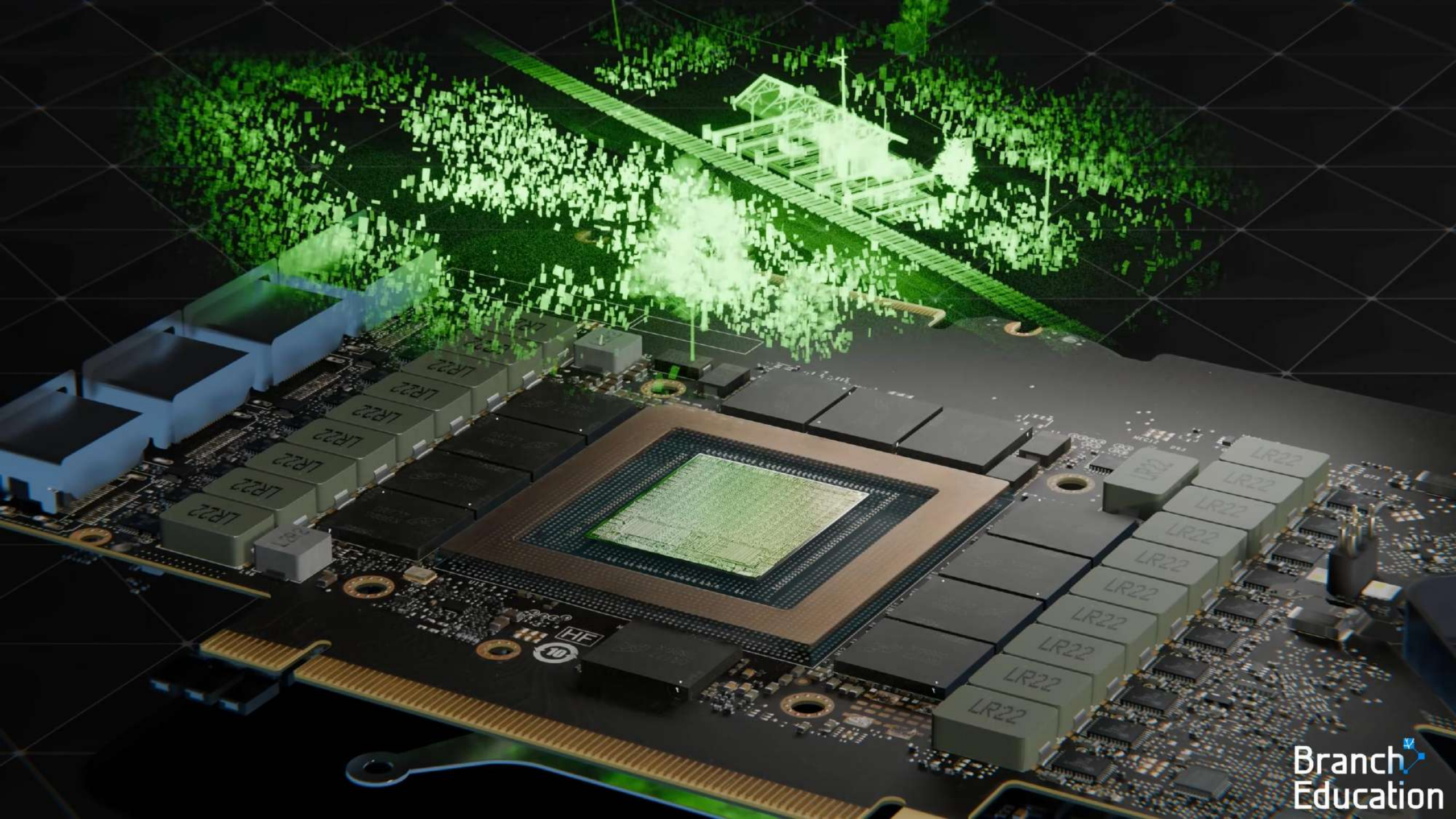

Graphics Memory Chips
Solid State Drive
micron
crucial
T705
Branch
Education

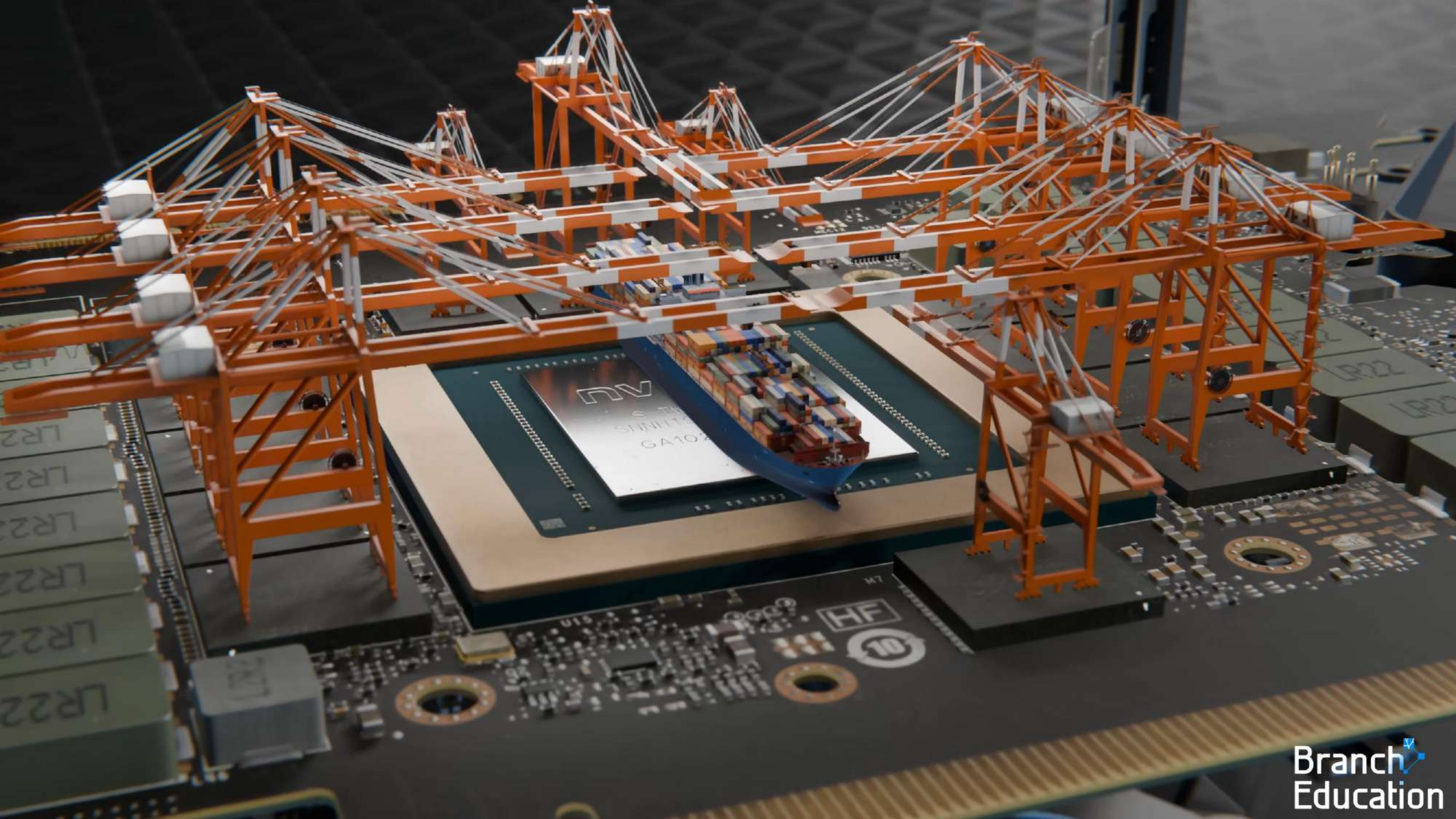

Graphics Memory Chips
micron
crucial
T705
PCIe®Gen5 NVMe™ M.2 SSD
Solid State Drive
Branch
Education


L2 Cache
3 MB
L2 Cache
3 MB
Branch
Education

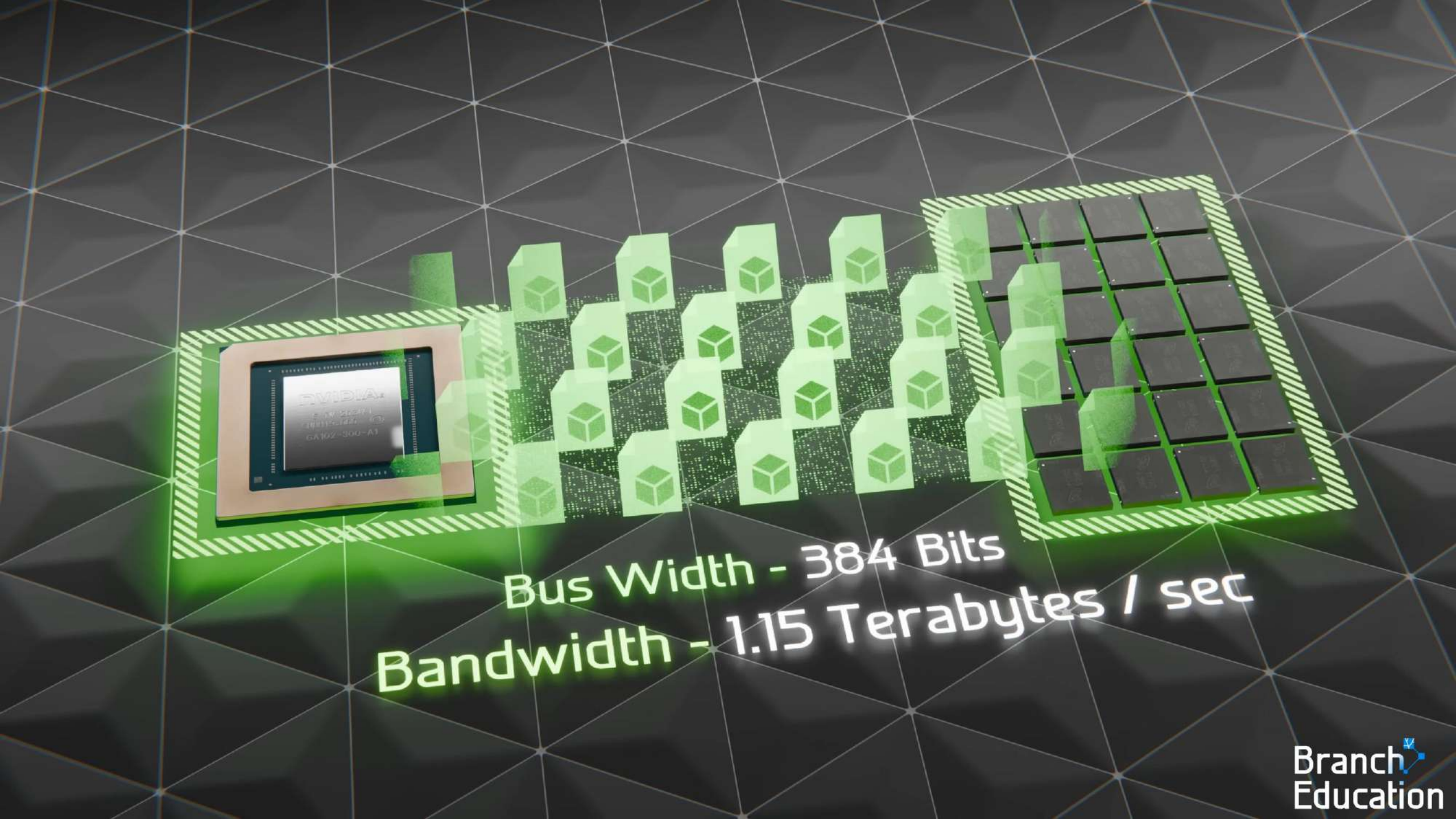

Branch
Education

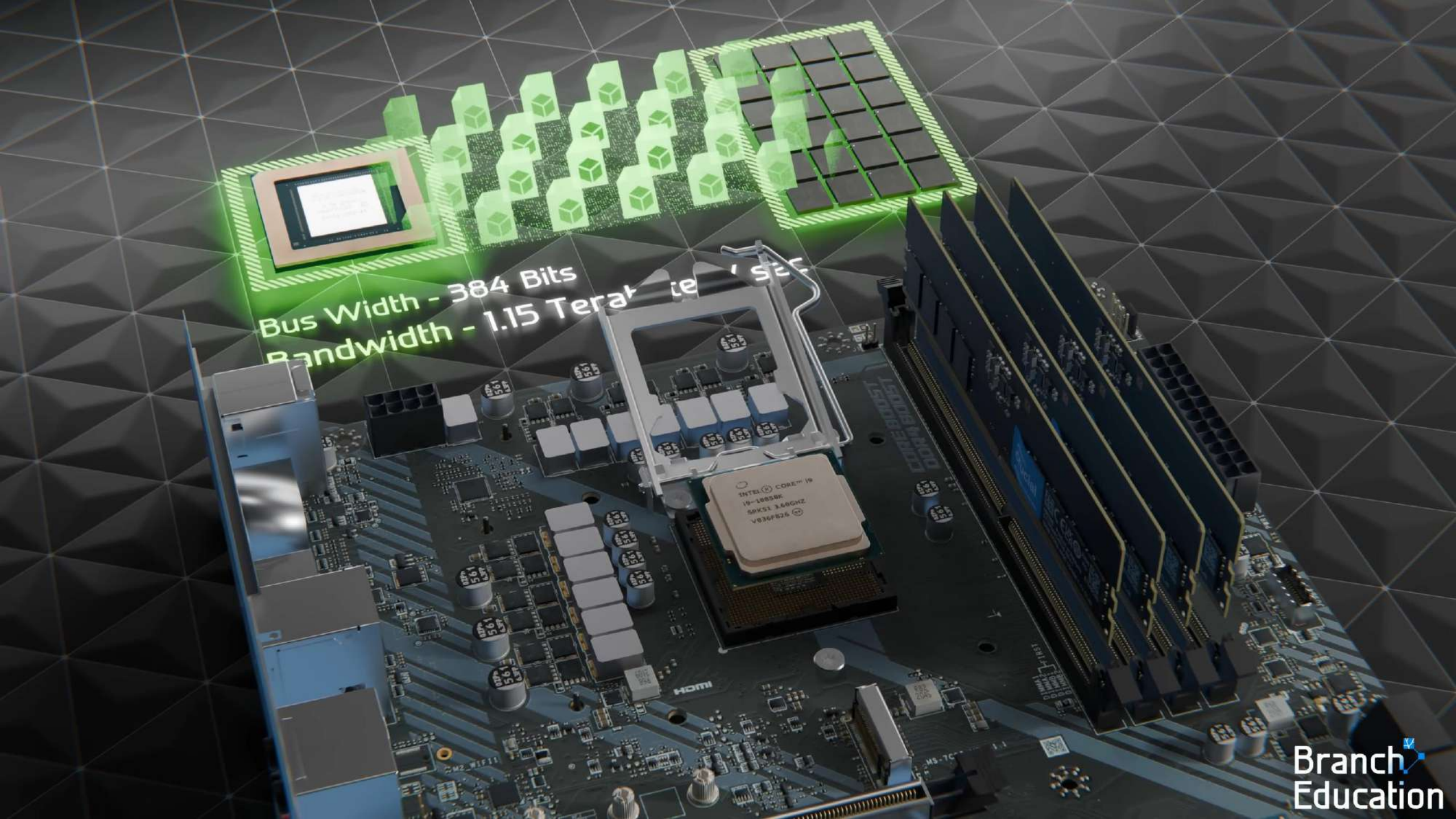

Branch
Education

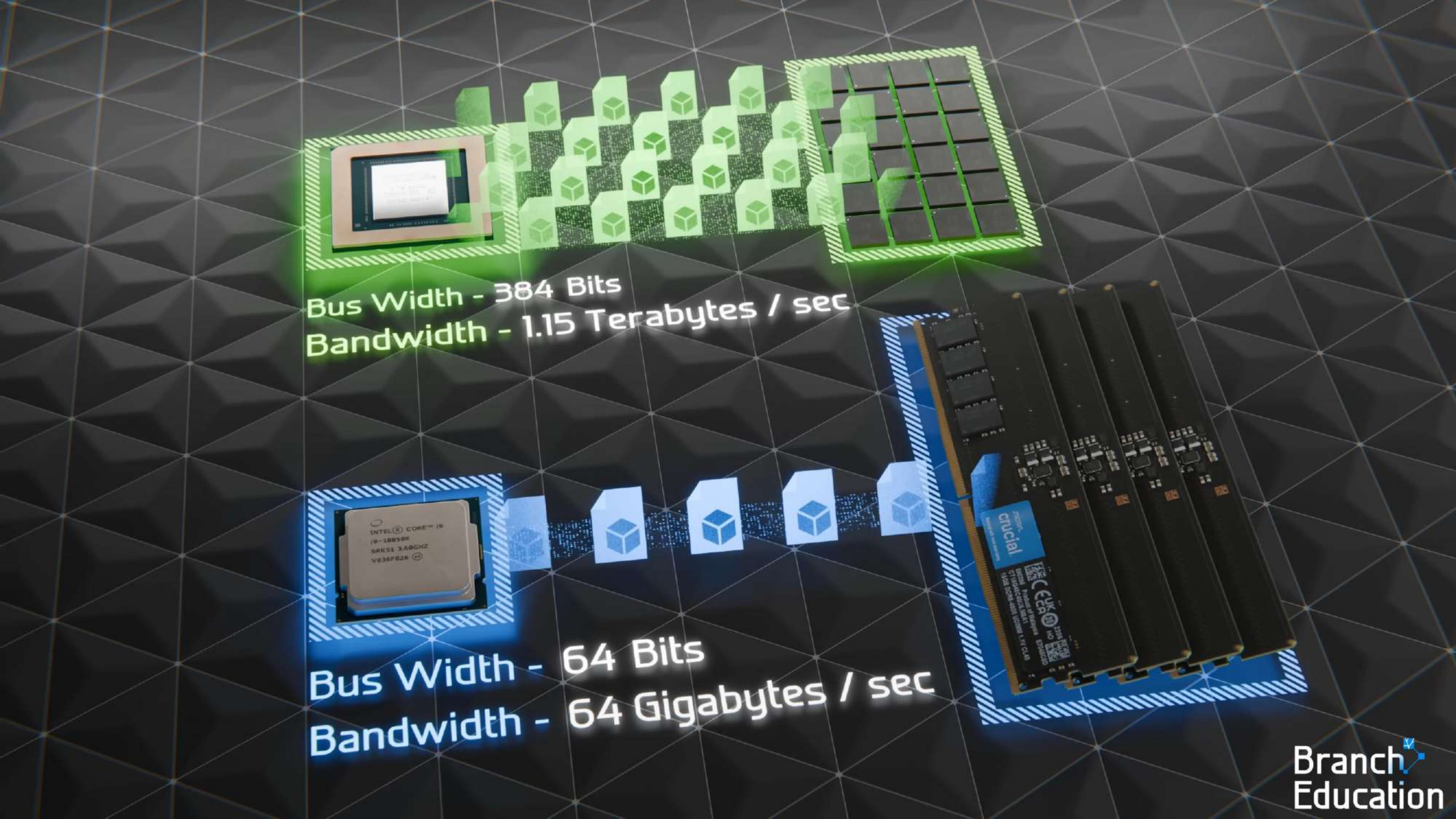

LR22
HF
Branch
Education


Branch
Education

Branch
Education


Bus Width - 384 Bits
Bandwidth - 1.15 Terabytes / sec
Branch Education


Bus Width - 384 Bits
Branch
Education


Bus Width - 384 Bits
Bandwidth - 1.15 Terabytes / sec
Bus Width - 64 Bits
Bandwidth - 64 Gigabytes / sec
Branch Education

실제 게임 속 병렬 연산

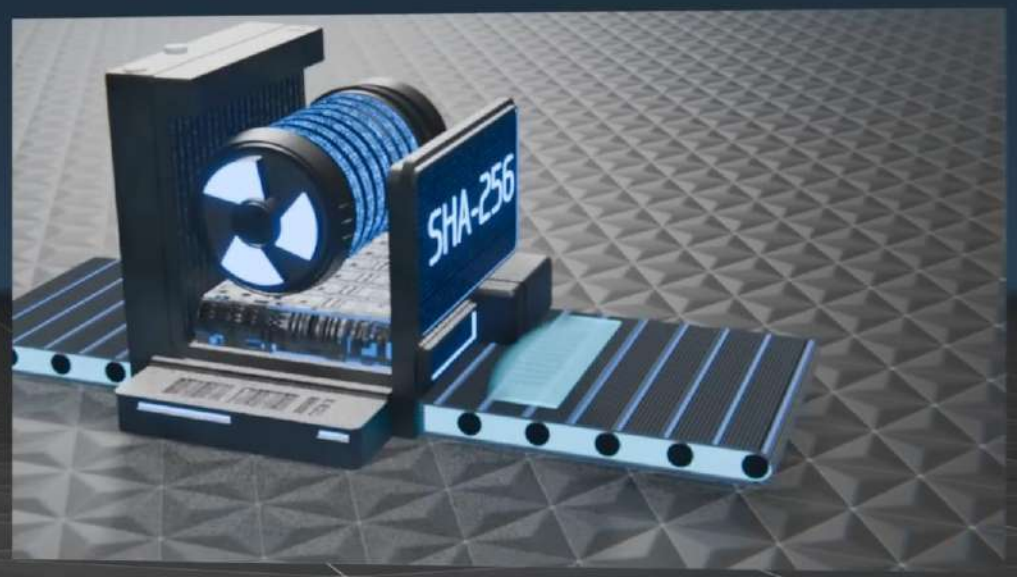
- 화면 1장을 그릴 때 수천만 개의 픽셀 연산
- 빛 반사, 표면 질감, 그림자 모두 연산해야 함
- 이걸 한 프레임에 60번? → 병렬 처리 아니면 불가능

Problems

Branch Education

Video Game

Bitcoin Mining

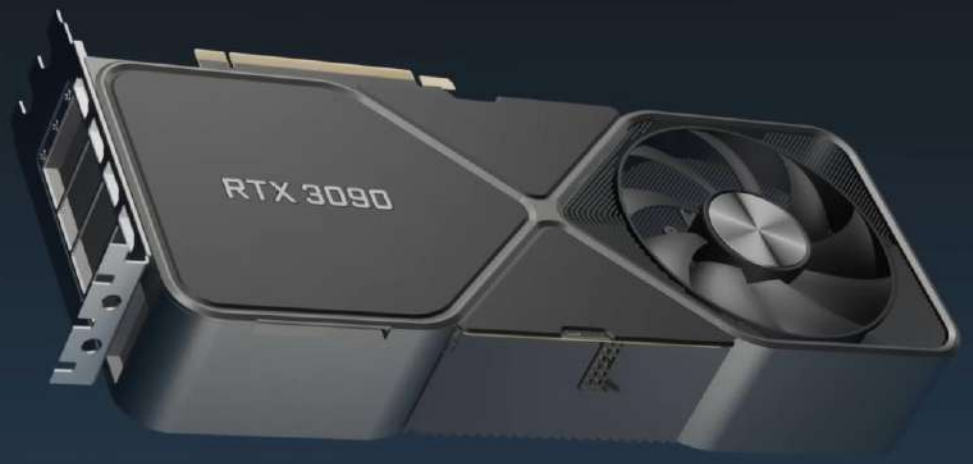


Branch Education

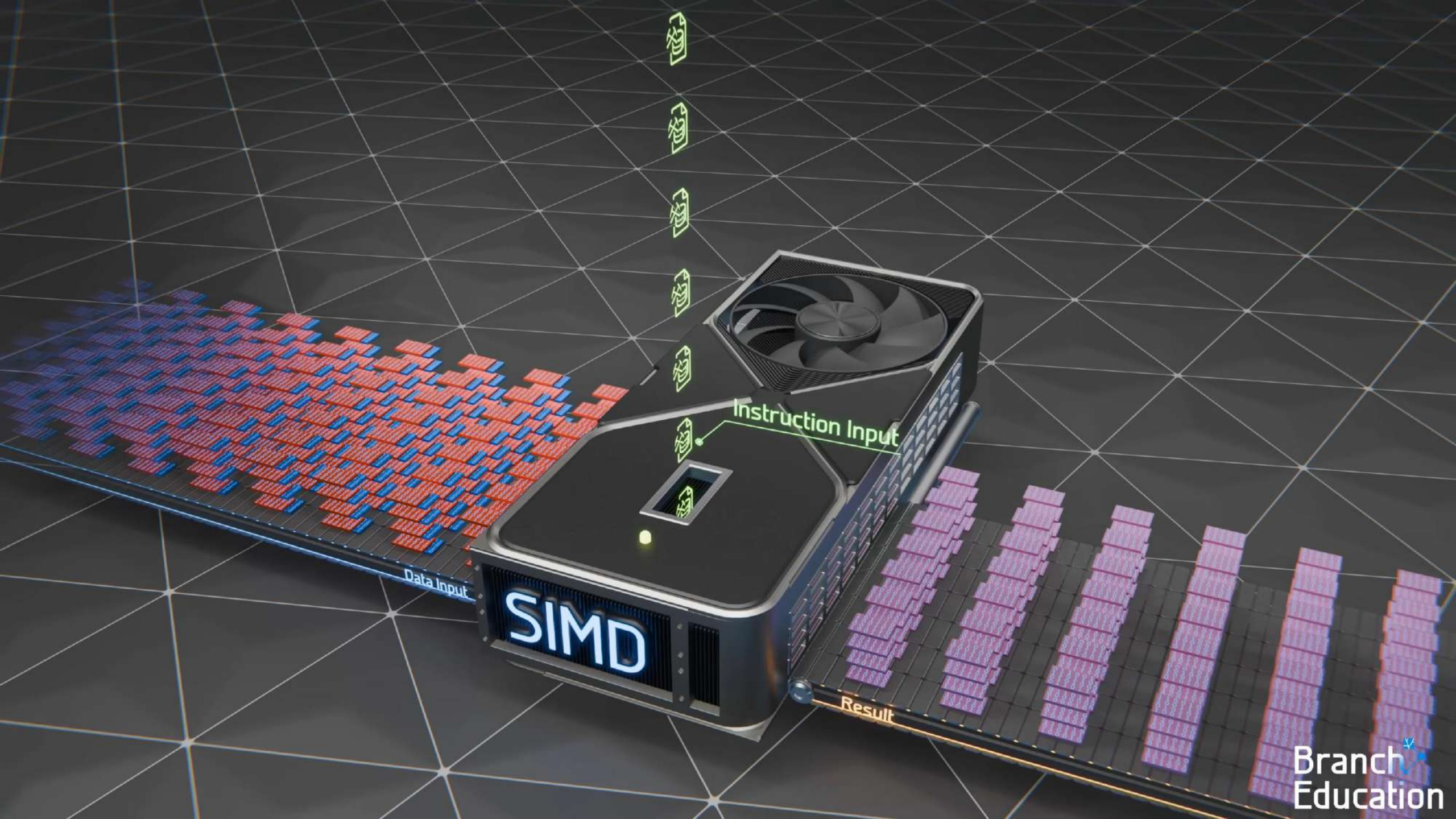
SIMD

Branch Education

Single Instruction Multiple Data



Branch Education


Instruction Input
Data Input
SIMD
Result
Branch Education

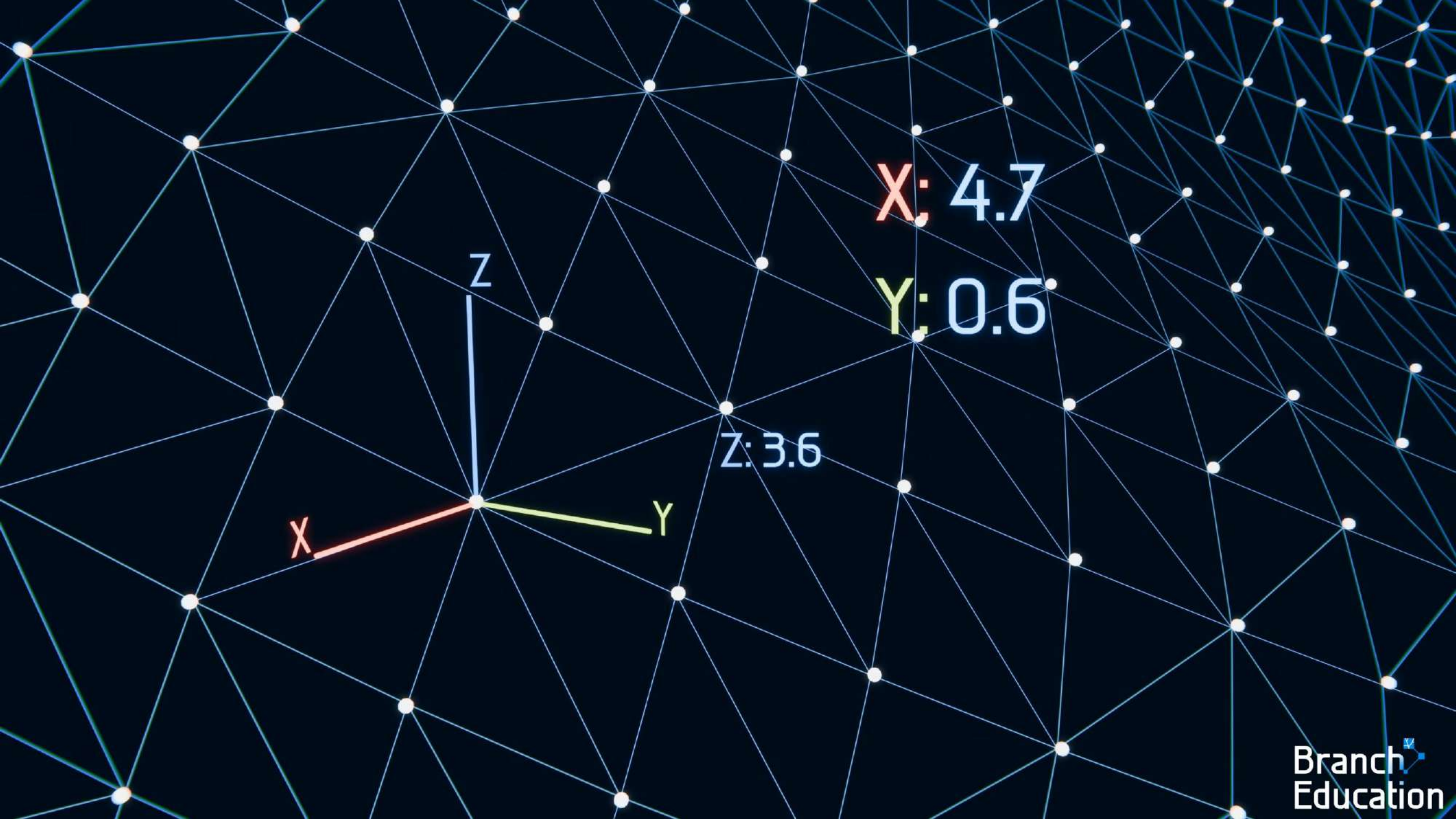
SIMD
Single Instruction Multiple Data
Branch Education

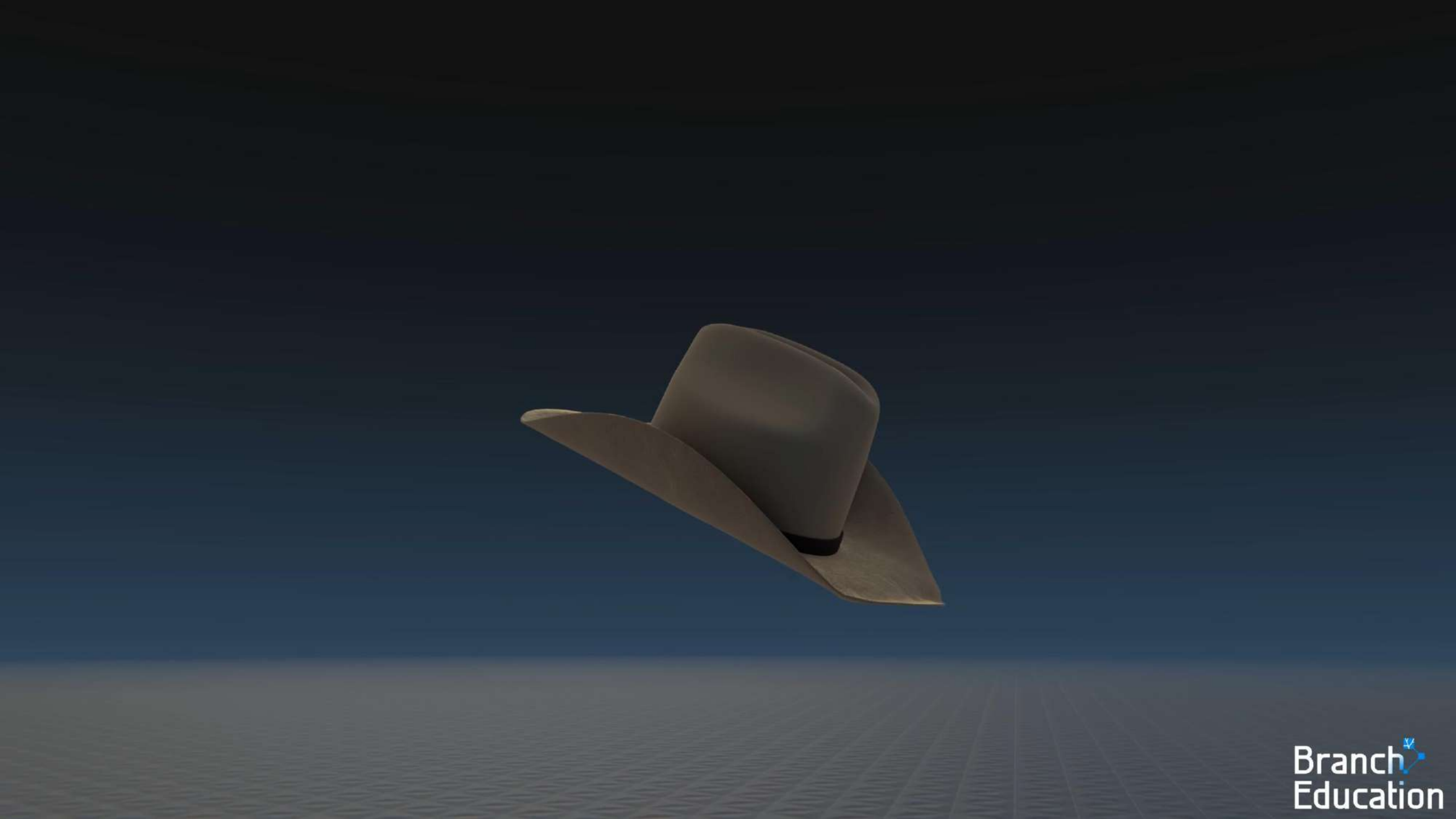
Branch Education

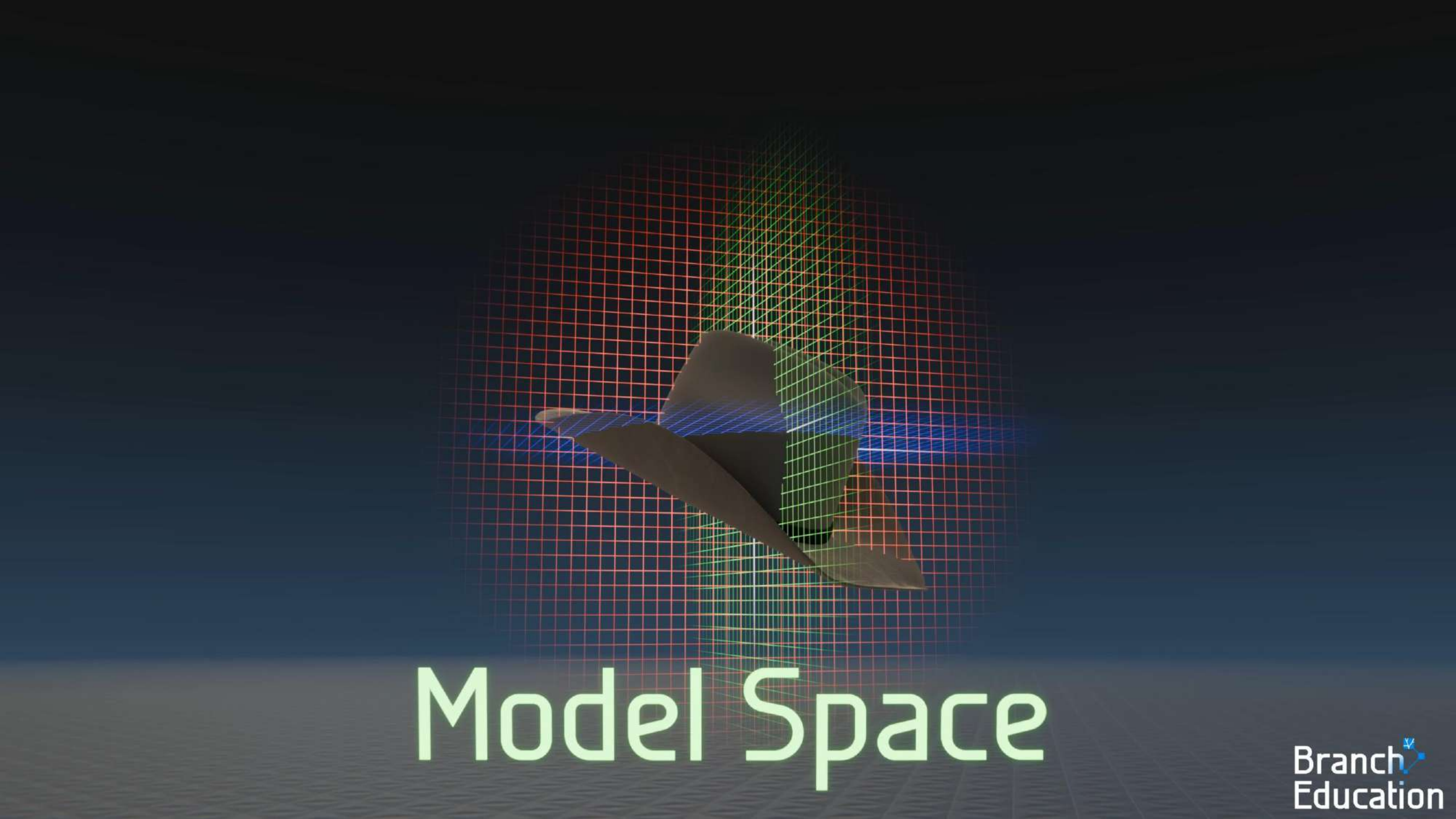
Branch
Education

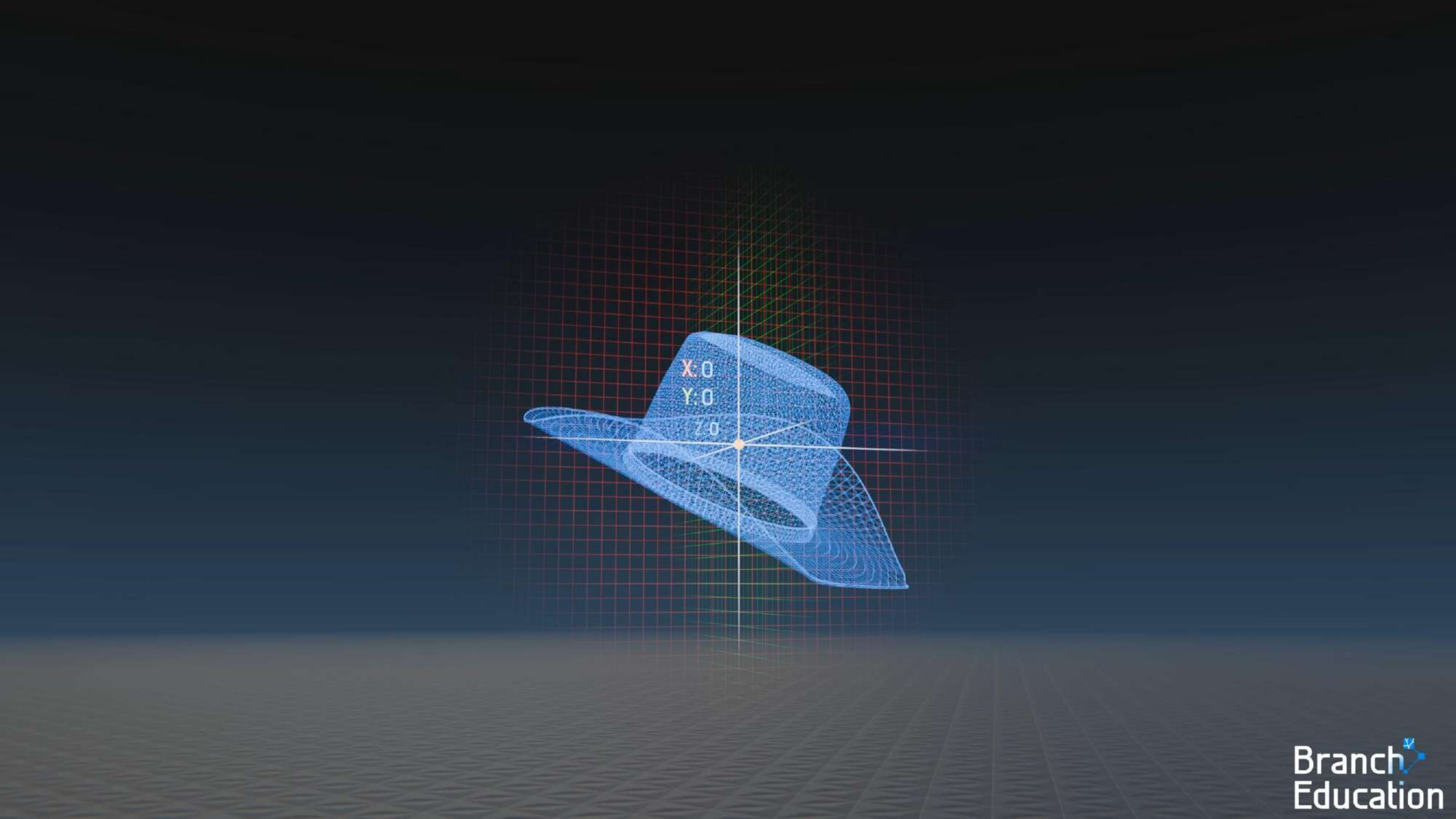
24 640 Triangles
Branch
Education

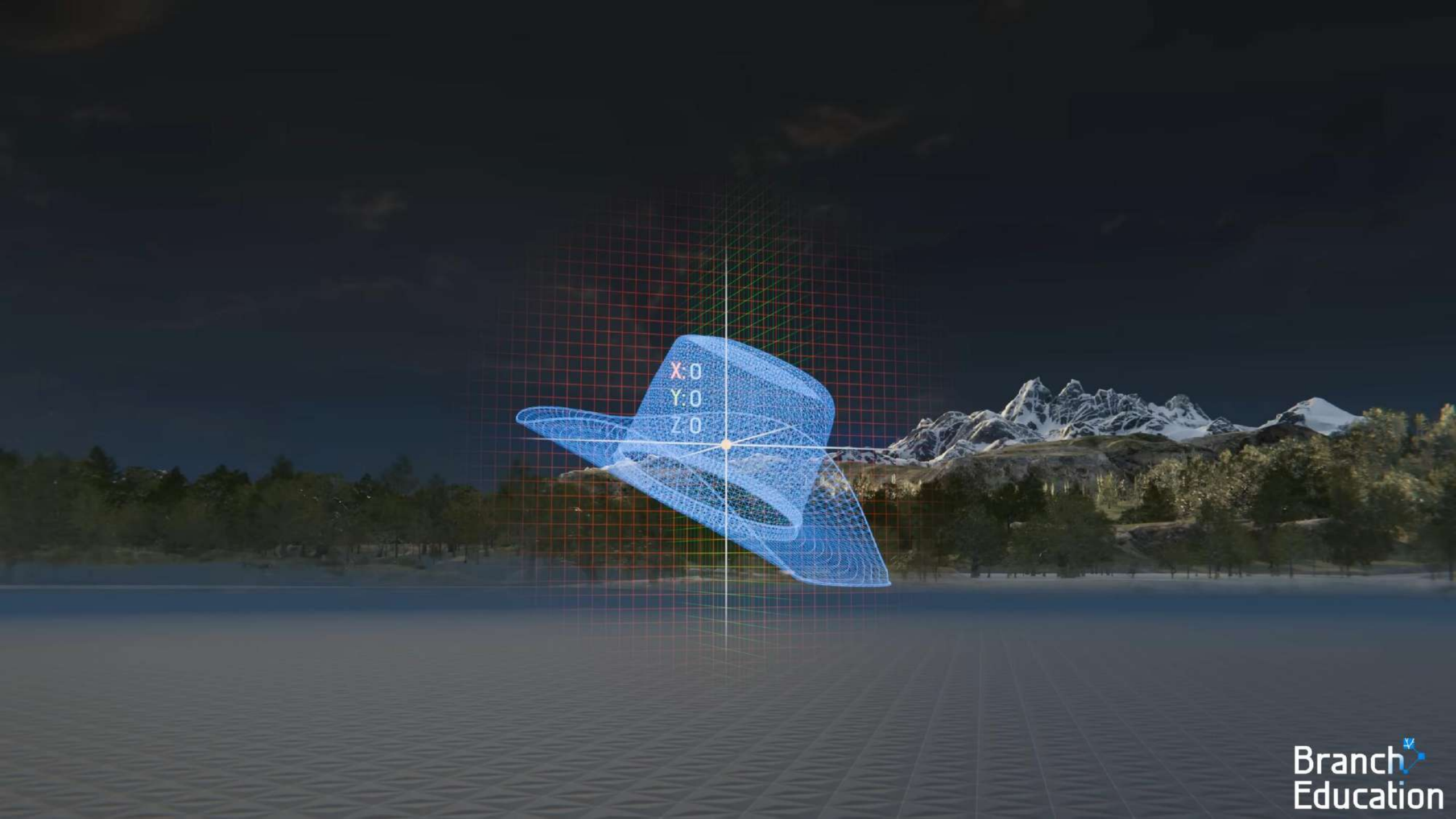
12 880 Vertices
Branch
Education


X: 4.7
Y: 0.6
Z: 3.6
Z
X
Y
Branch Education

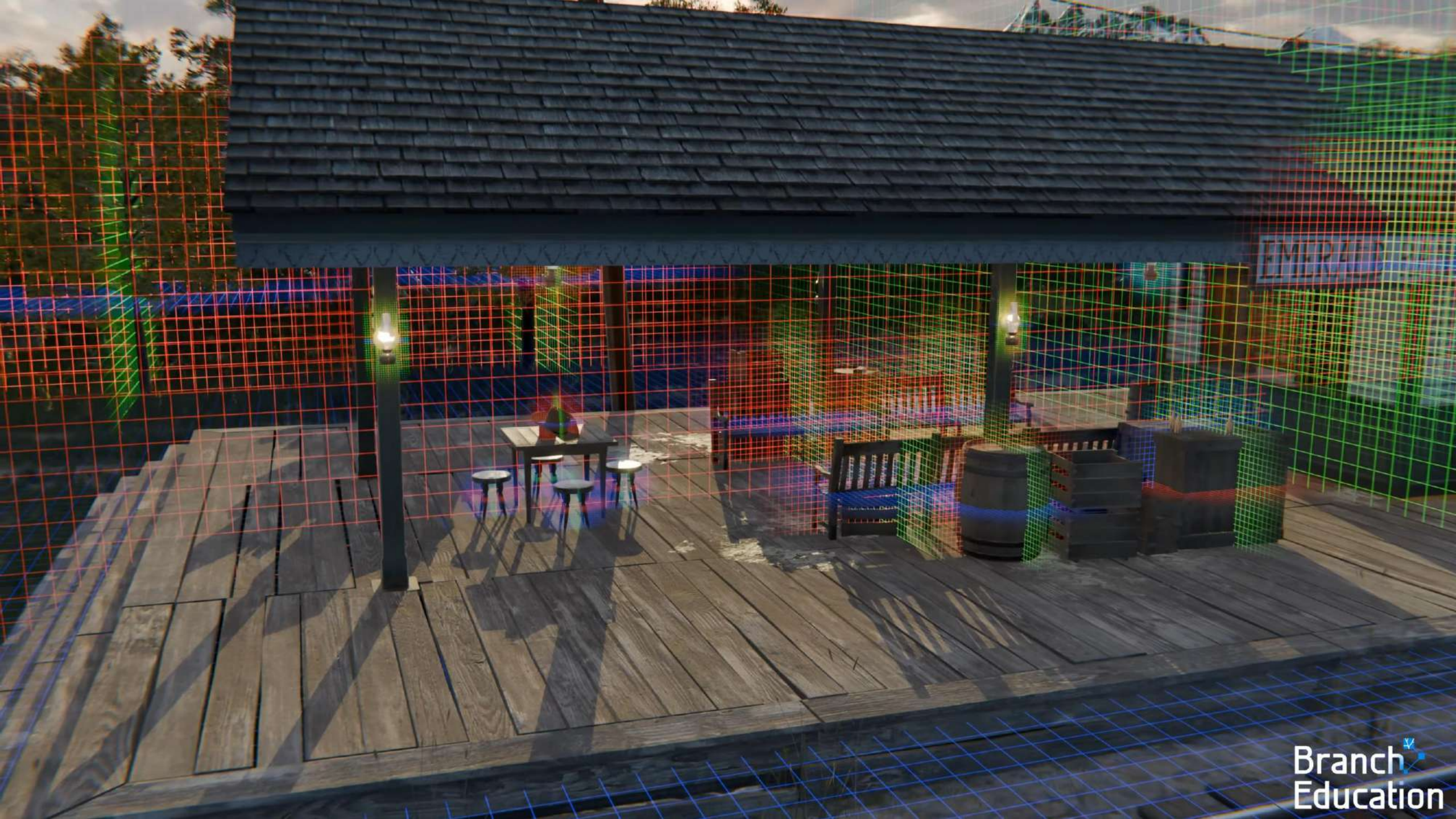

Branch
Education

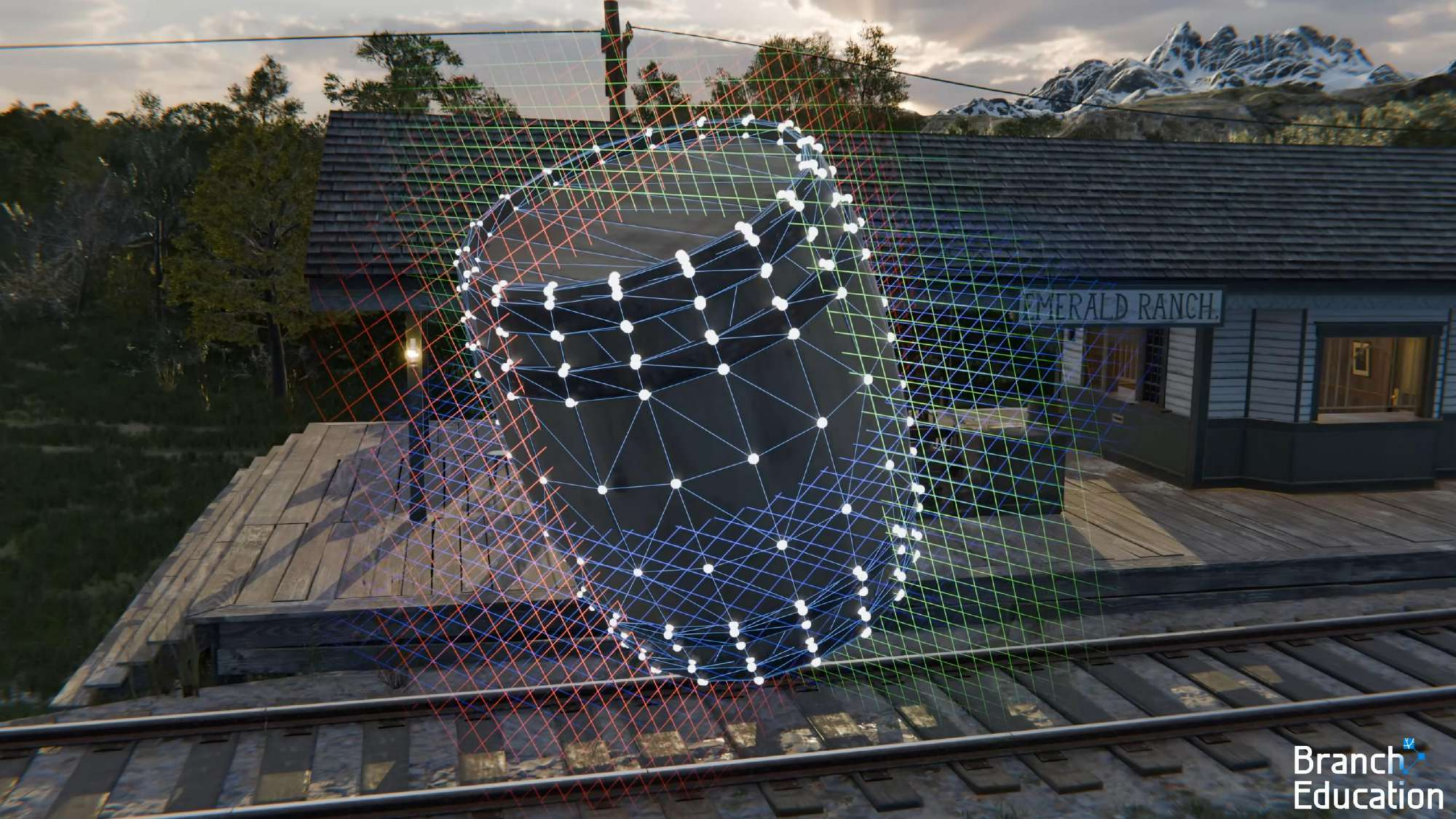

Model Space
Branch
Education


X: 0
Y: 0
Z: 0
Branch
Education


X: 0
Y: 0
Z 0
Branch
Education

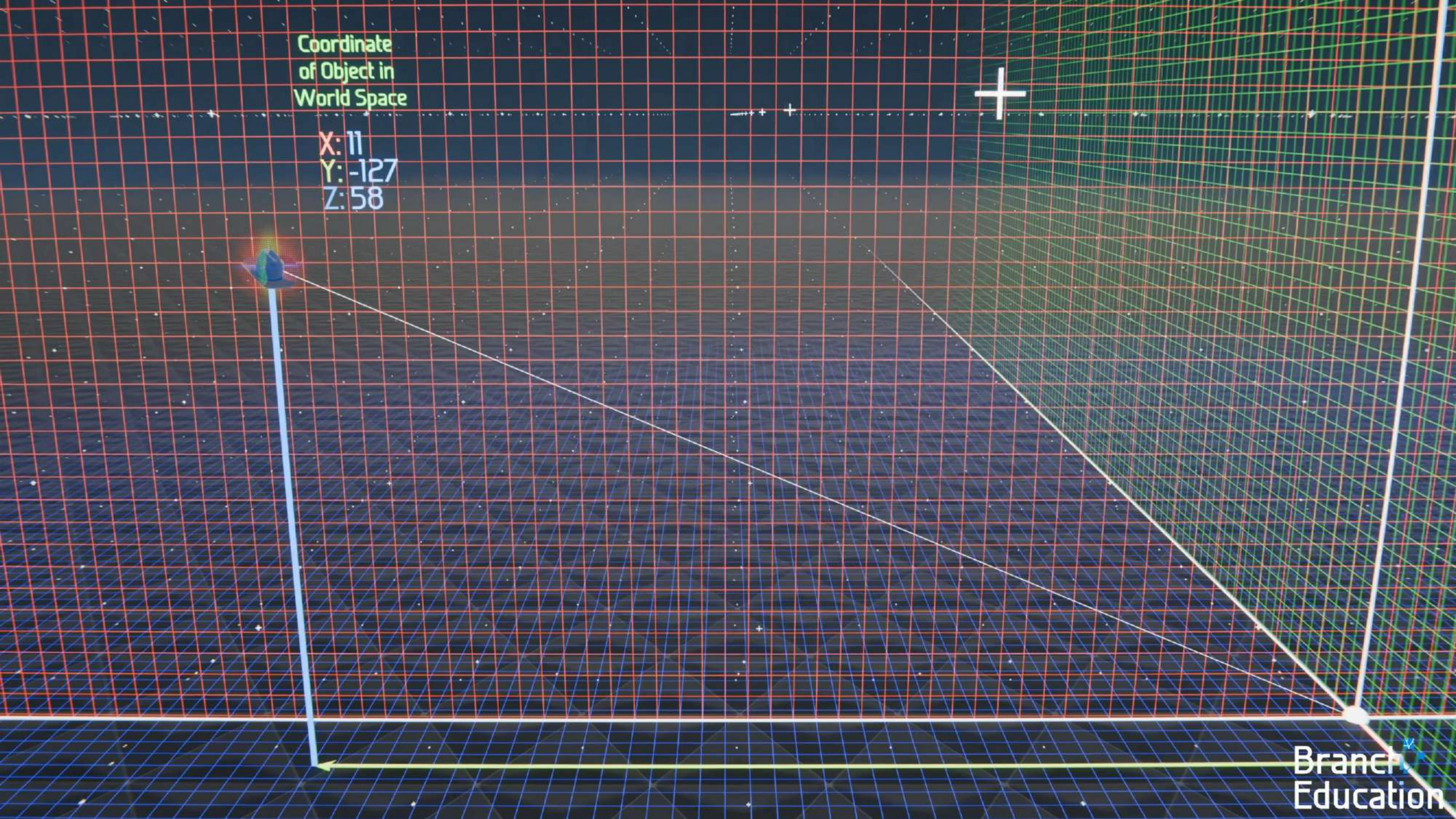
Branch
Education

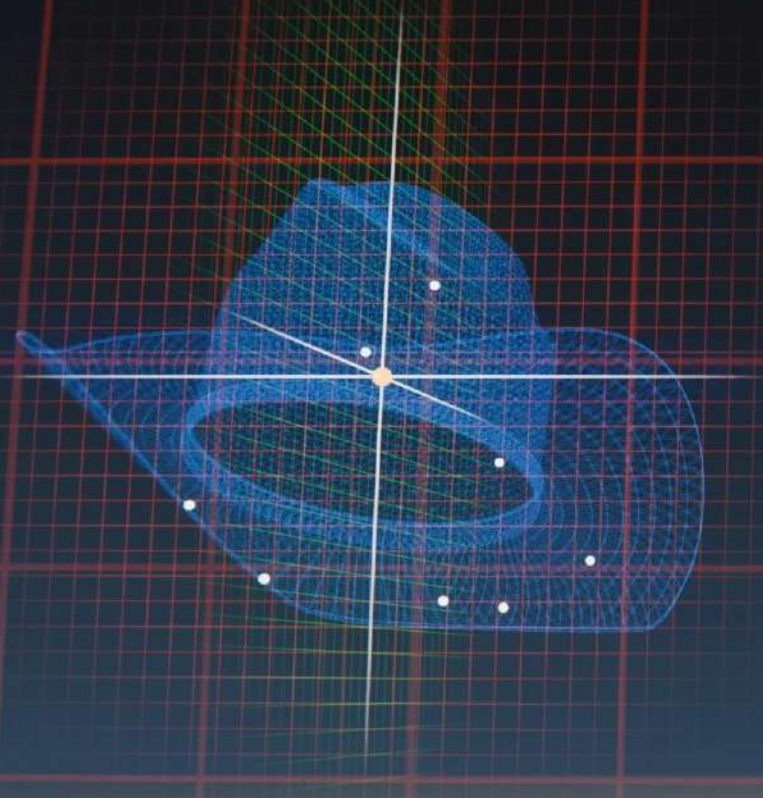

EMERALD
Branch
Education


EMERALD RANCH.
Branch
Education

Branch
Education

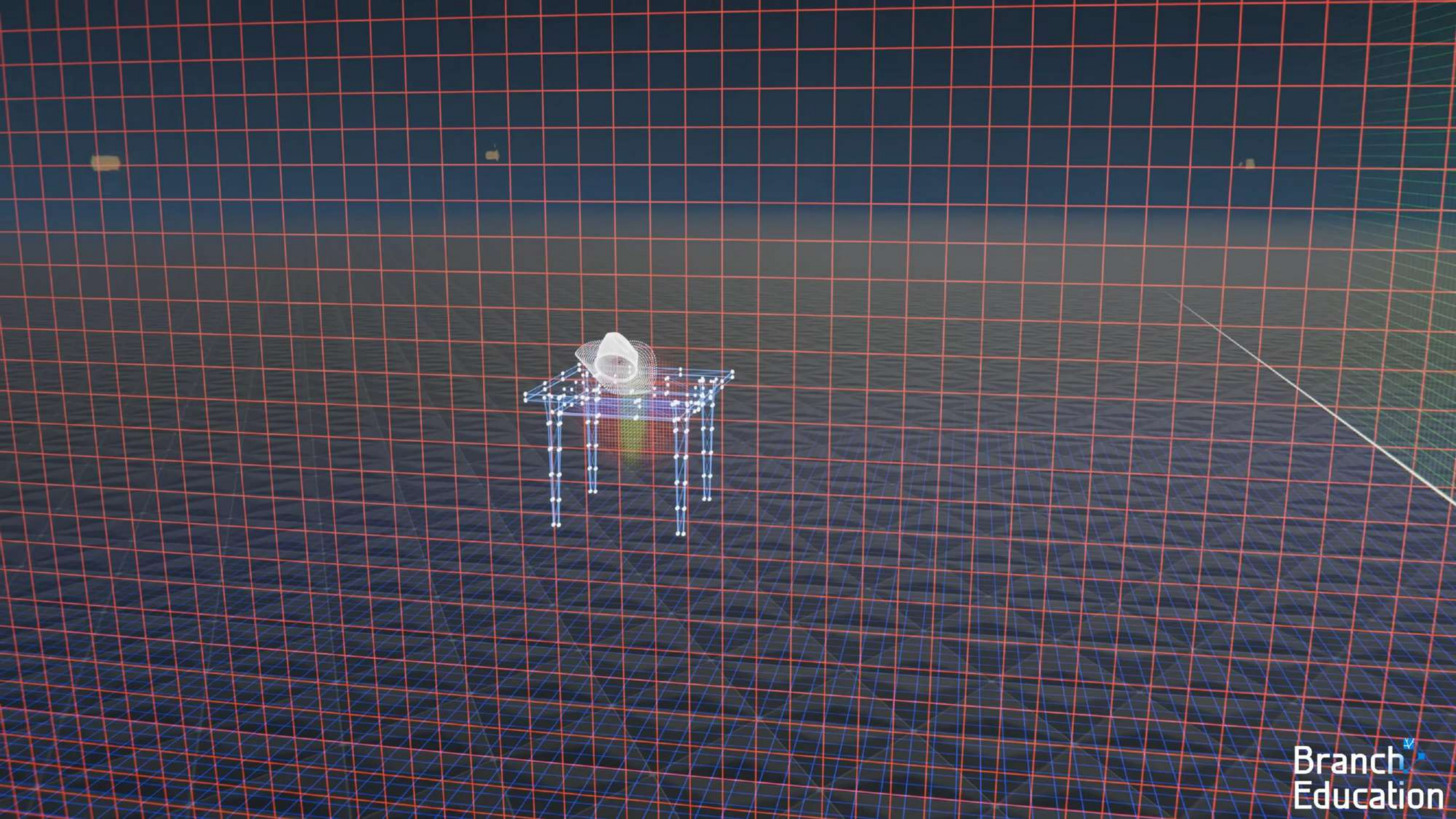
Branch
Education

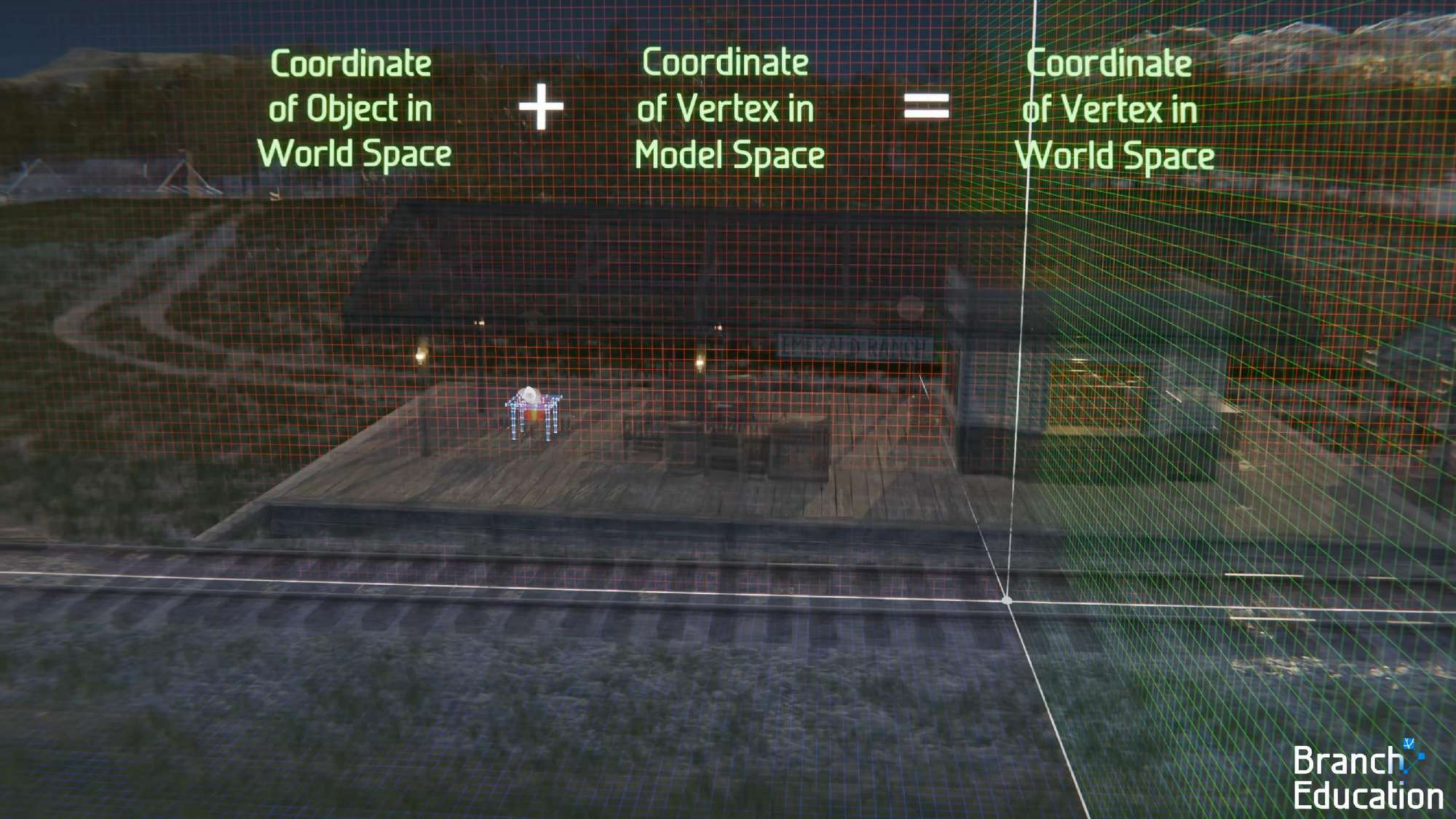

Coordinate
of Object in
World Space
X: 11
Y: -127
Z: 58
Branch
Education

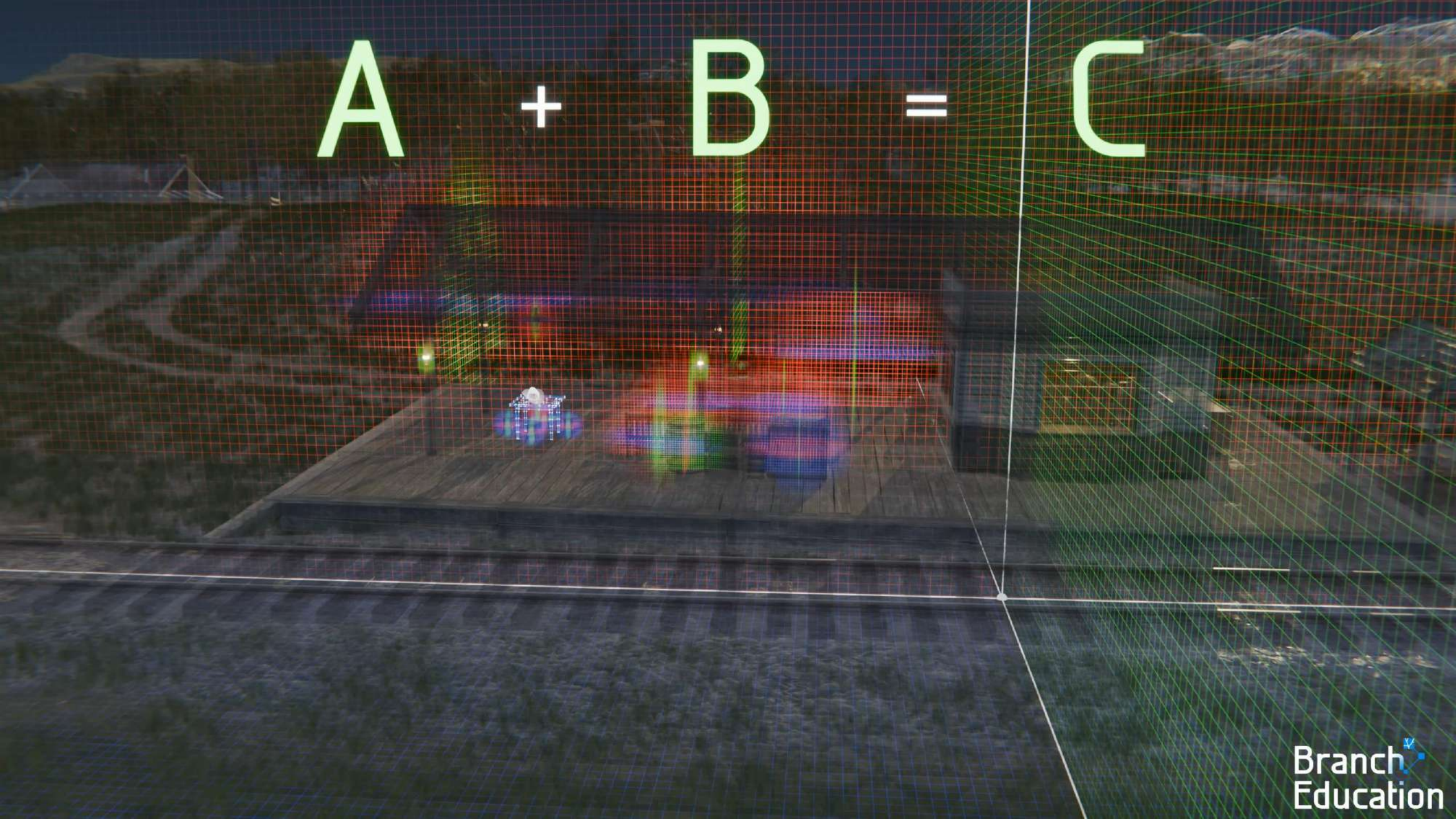


Coordinate of Object in World Space		Coordinate of Vertex in Model Space		Coordinate of Vertex in World Space
X: 11 Y: -127 Z: 58	+	X: 0.74 Y: 0.43 Z: 0.25	=	X: 11.74 Y: -126.57 Z: 58.25
		Vertex 2		
X: 11 Y: -127 Z: 58	+	X: -0.13 Y: 0.92 Z: 0.73	=	X: 10.87 Y: -126.08 Z: 58.73
		Vertex 3		
X: 11 Y: -127 Z: 58	+	X: 0.8 Y: -0.55 Z: -0.47	=	X: 11.80 Y: -127.55 Z: 57.53
		Vertex 4		
X: 11 Y: -127 Z: 58	+	X: 0.63 Y: 0.16 Z: -0.22	=	X: 11.63 Y: -126.84 Z: 57.78
		Vertex 5		
X: 11 Y: -127 Z: 58	+	X: -0.38 Y: 0.5 Z: -0.71	=	

Branch Education

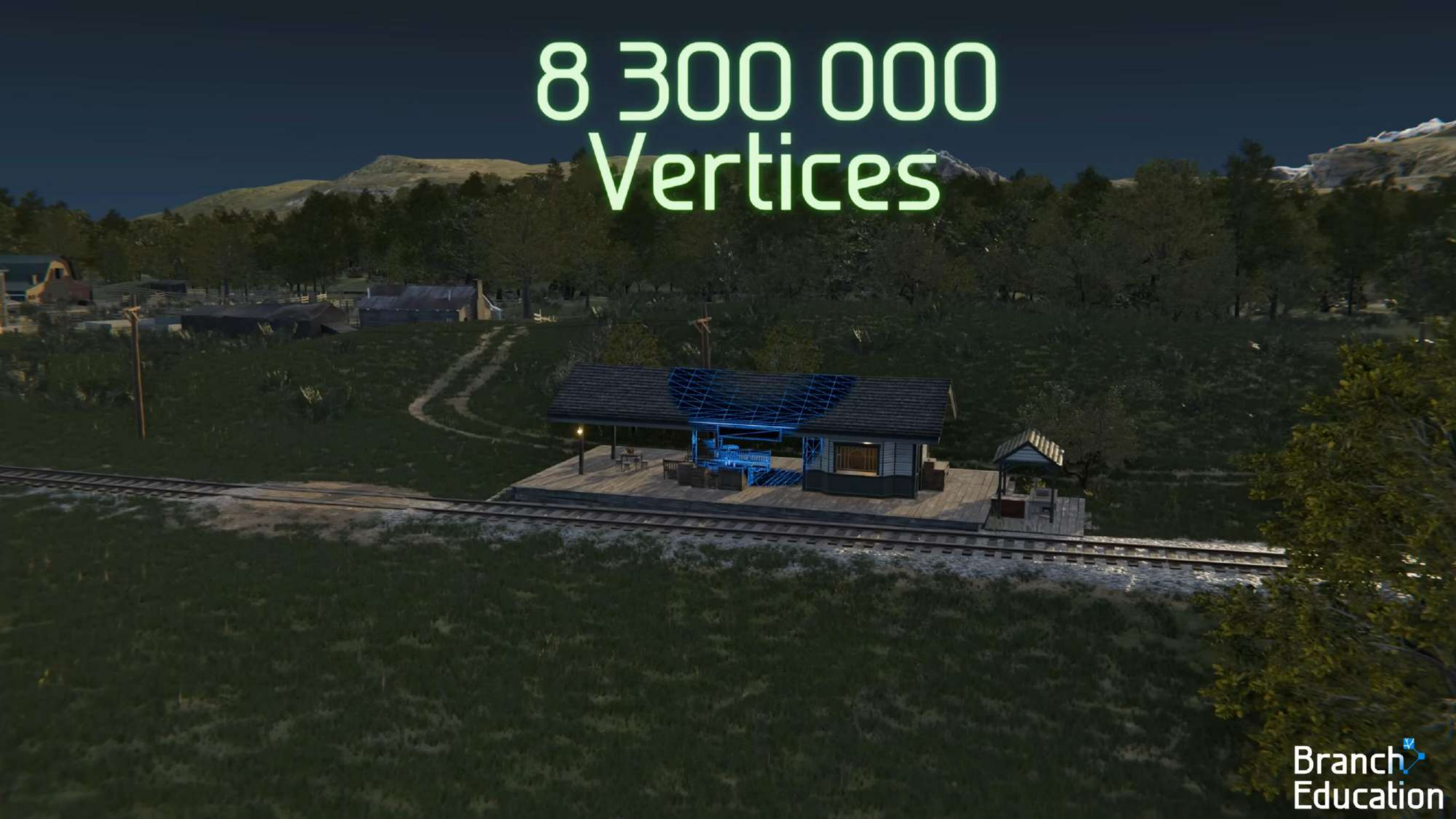

Branch
Education


Coordinate of Object in World Space
+
Coordinate of Vertex in Model Space
=
Coordinate of Vertex in World Space
EMERALD RANCH
Branch Education


A + B = C
Branch Education

Branch
Education

5 629
Objects
Branch
Education

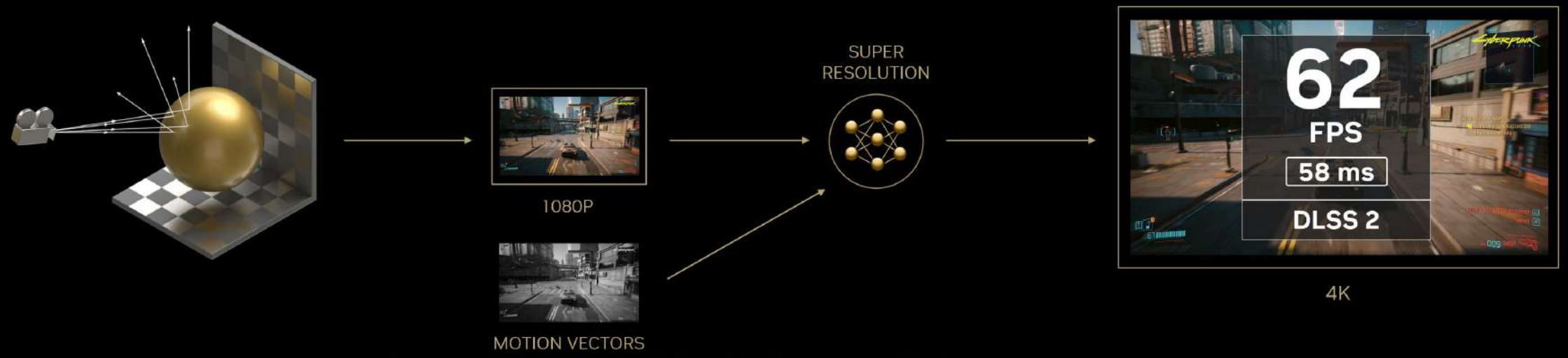

8 300 000
Vertices
Branch
Education

25 000 000
Calculations
EMERALD RANCH
Branch
Education

DLSS (Deep Learning Super Sampling)

- 저해상도로 렌더링 → AI가 고해상도 이미지 생성
- 성능은 올리고, 화질은 유지

NVIDIA DLSS 2: AI SUPER RESOLUTION



REAL-TIME MOTION ESTIMATION WITH ADA OPTICAL FLOW ACCELERATOR

For each pixel region in frame 1

Find matching pixel region in frame 2

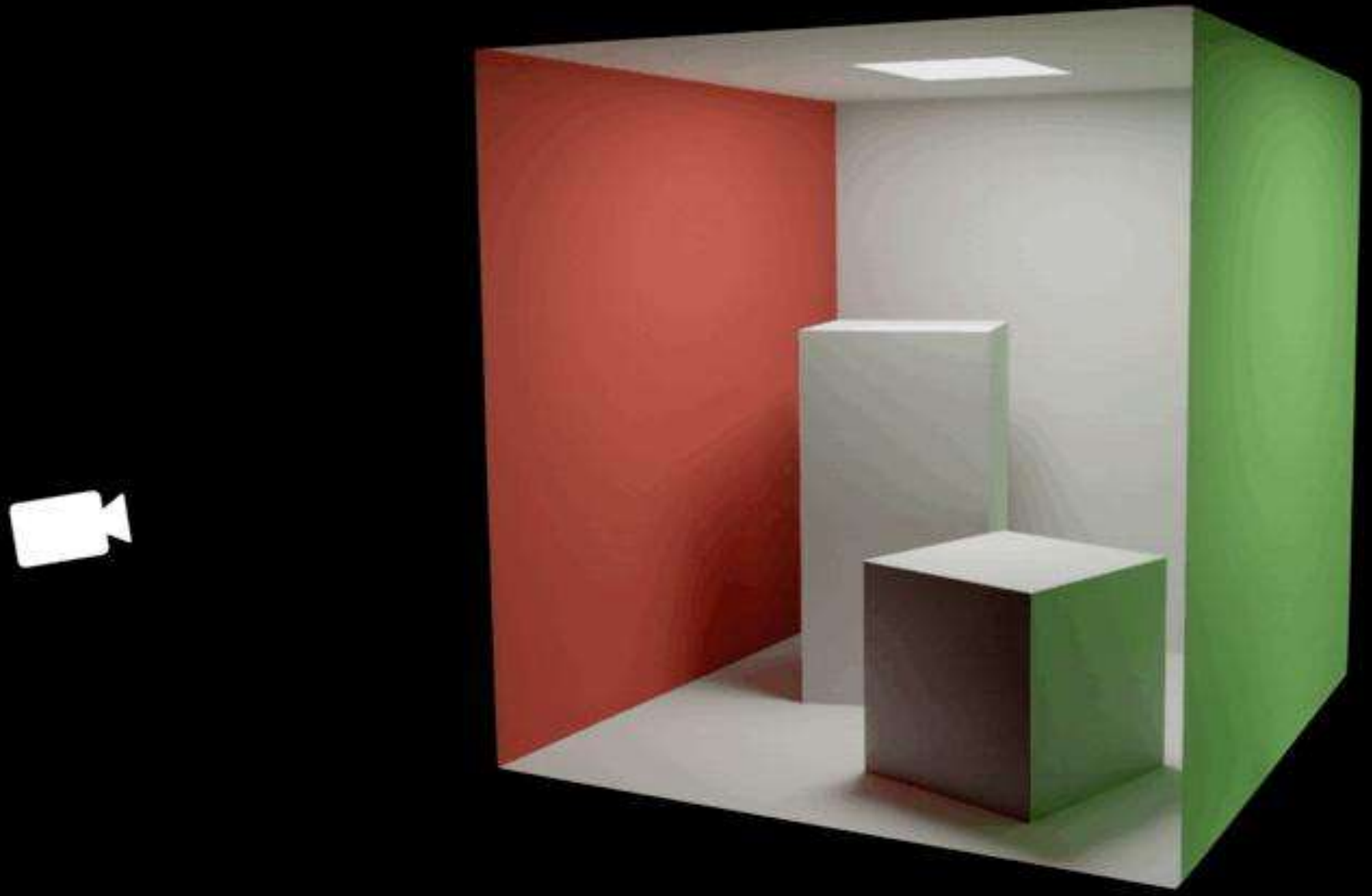
Calculate motion flow

DLSS 작동 방식 요약

- 저해상도 렌더링:
  - GPU는 실제보다 낮은 해상도로 프레임을 렌더링해 계산량을 줄임
- 모션 벡터 + 뎁스 맵:
  - 이전 프레임의 움직임 정보와 깊이 정보 활용
- AI 모델 추론:
  - AI가 학습된 네트워크를 사용해 고해상도 이미지를 재구성
- 출력:
  - 최종적으로 고해상도 프레임을 사용자에게 보여줌

RTX: 실시간 레이트레이싱의 혁신

- 과거엔 CG 영화만 가능하던 걸 실시간으로
- 빛의 반사, 굴절, 그림자가 실제처럼 묘사됨

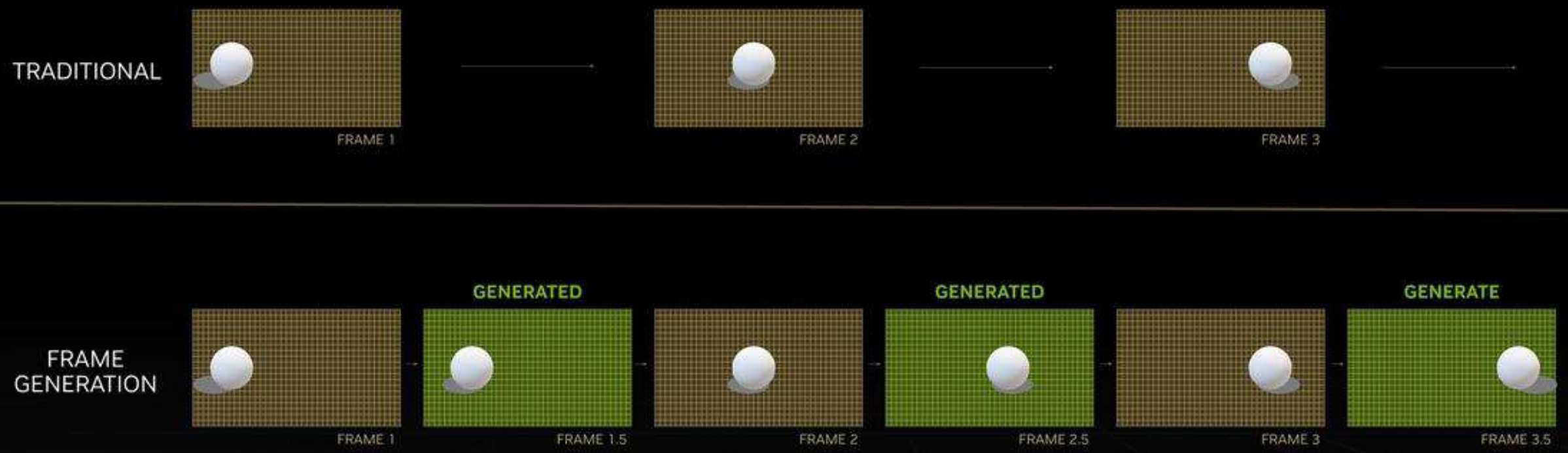


Frame Generation

- 원래 존재하지 않는 프레임을 AI가 생성
- 마우스나 카메라 움직임 예측 기반

FRAME GENERATION POTENTIAL

Animation Smoothness | Overcome CPU Bottlenecks | Amazing RT Effects



이 기술들이 바꾼 게임 환경

- Cyberpunk 2077,
- Alan Wake 2,
- Hogwarts Legacy 등

DLSS 기술이 도입되면서 게임 환경은
그래픽 품질을 포기하지 않고도
더 높은 성능을 얻을 수 있는 시대로 바뀌었다.

- 예전에는 고해상도 + 레이트레이싱 옵션을 켜면
  프레임이 급격히 떨어져서 현실적으로 사용 불가

- DLSS는 낮은 해상도로 렌더링하고,
  AI가 고해상도로 보정해줘서 고옵션도 ‘쓸 수 있는 것’이 됨

- 이제는 고사양 그래픽을 기술적으로 가능하게 만든 전환점

DLSS 같은 기술은
하드웨어 발전의 물리적 한계를,
소프트웨어 알고리즘으로 극복한 대표적인 사례

왜 DLSS는 시대의 전환점인가?

트랜지스터 미세화의 한계

- 무어의 법칙은 거의 정체 상태에 가까워짐
- 5nm, 3nm까지 왔지만 더 줄이는 건 수율·열·전력·비용 문제로 쉽지 않음
- GPU에 더 많은 코어를 넣는 것도 전력벽(Thermal/Power Wall) 때문에 어려움

“알고리즘이 트랜지스터를 대체한다”는 철학

- DLSS는 성능을 높이기 위해 ‘더 강한 하드웨어’를 쓰는 대신
- 더 똑똑한 소프트웨어를 써서 ‘덜 그려도 더 좋아 보이게’ 만든 기술
- 즉, “가짜 프레임”으로 “체감 성능”을 만드는 것
- 딥러닝 기반 예측이라는 고도화된 소프트웨어 설계 덕분에 가능

실습

[과제 안내] 5주차 선각 리포트

주제 : AI는 GPU 없이 존재할 수 있는가?

주제 해설 : AI는 인간처럼 생각하는 기술입니다.
하지만 오늘날의 AI는 대부분 GPU 위에서 작동합니다. GPU 없이도 AI가 존재할 수 있을까요?

제출 방법

- 파일명: `홍길동_5주차_선각리포트.pdf`
- 형식: PDF 변환 후 슬랙 `CHIP 톡방`에 제출
- 마감: 다음 모임 전까지
- 다음 모임 : 5월 31일 토요일 22시

다음 시간엔?

우리는 키보드, 마우스, 터치스크린, 시선 추적기 같은 입출력장치들이
어떻게 인간의 의도를 디지털 신호로 바꾸고,반대로 디지털 세상이
우리의 감각에 어떻게 피드백을 주는지 탐구합니다.
인간과 컴퓨터가 만나는 접점, 그 기술적 원리와 진화의 흐름을 살펴봅니다.

- 입출력장치와 휴먼-컴퓨터 인터페이스의 세계로 -