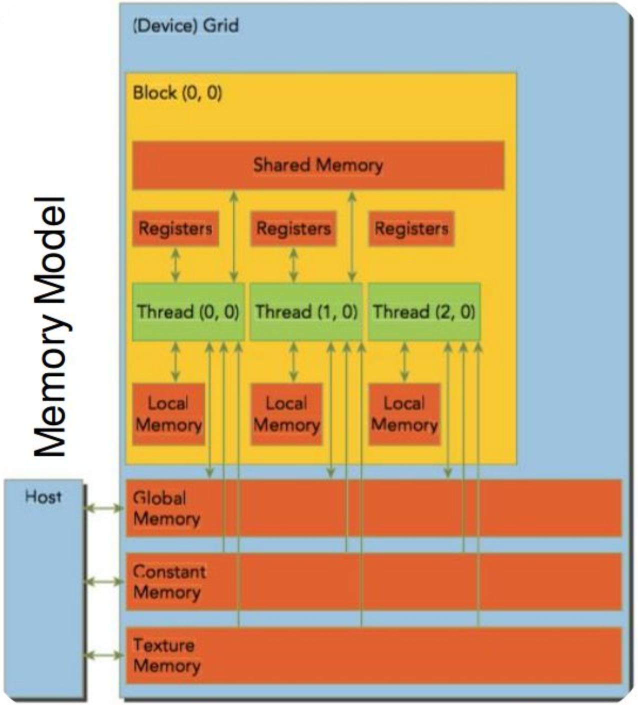
Global memory and Coalescing

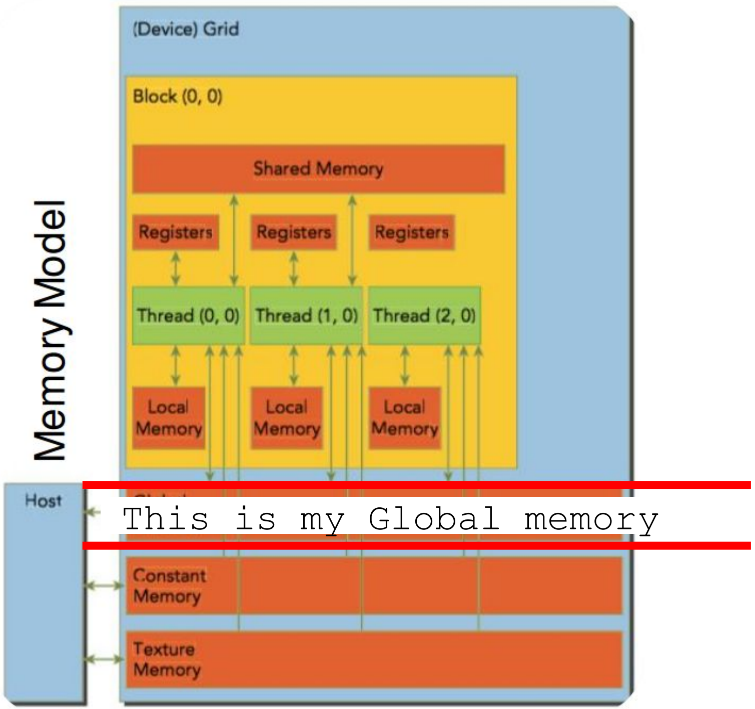
A click through example

By Nicolas Bohm Agostini

Memory Model



Memory Model



This is my Global memory

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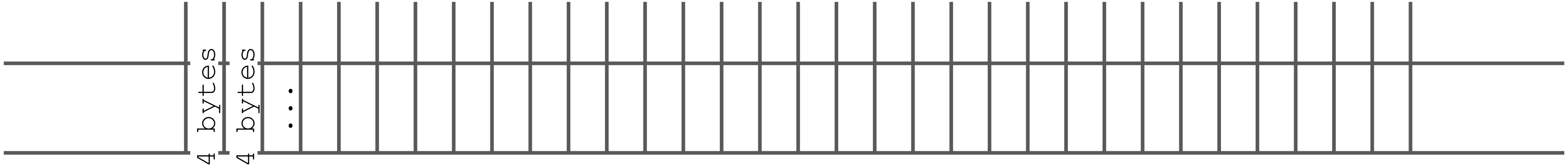
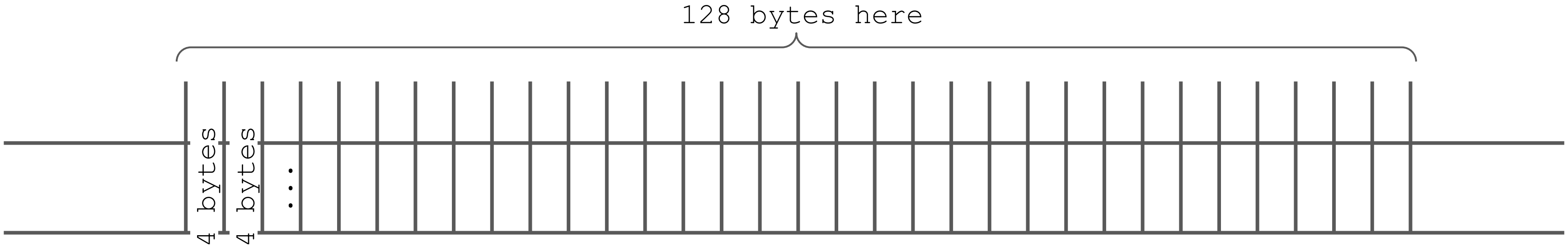


These are groups of
4 bytes


128 bytes here

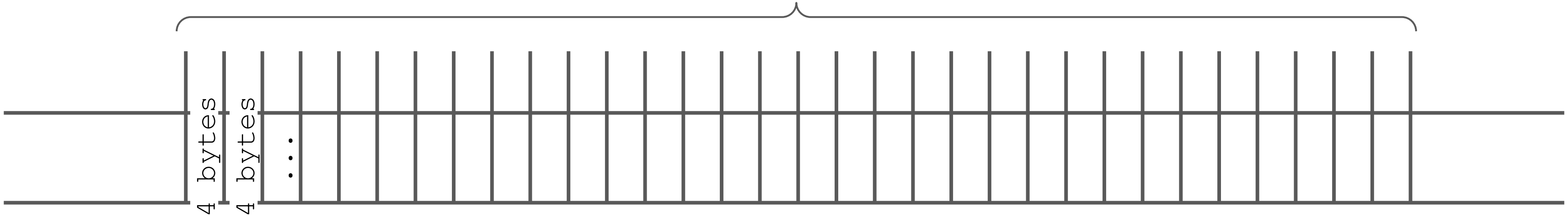
4 bytes

4 bytes

...

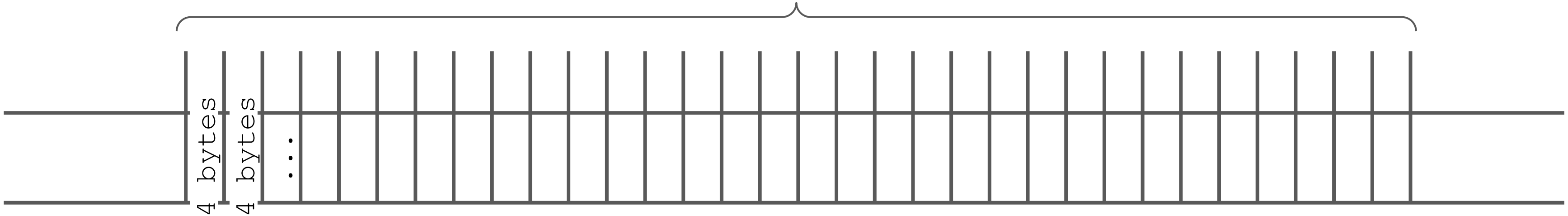
These are groups of
4 bytes

128 bytes here. 32 Groups of 4 bytes



These are groups of
4 bytes

128 bytes here. 32 Groups of 4 bytes

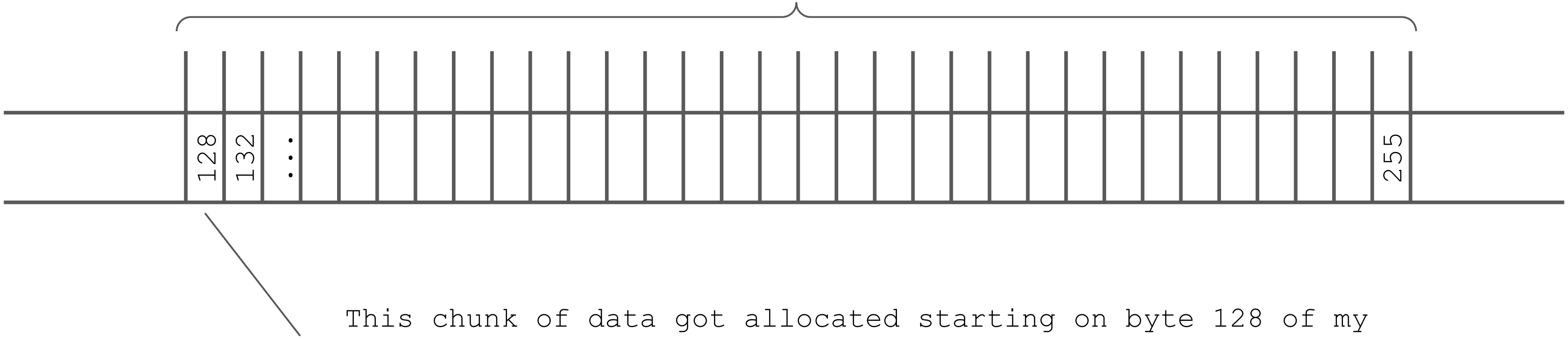


4 bytes

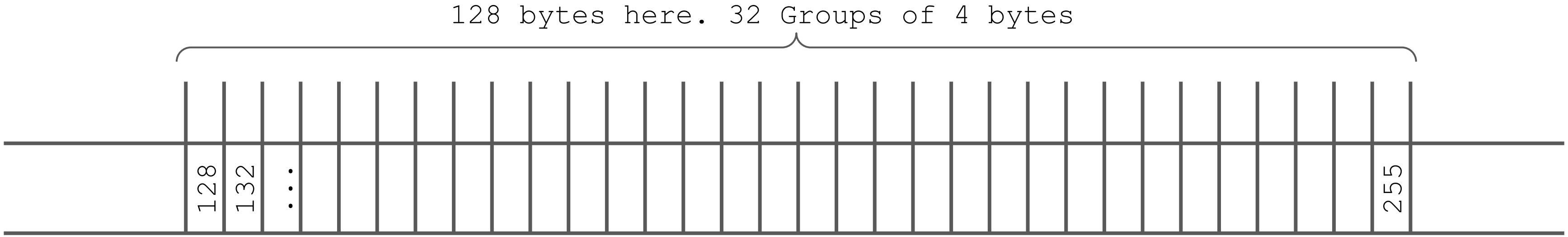
4 bytes

...

These are groups of
4 bytes



This chunk of data got allocated starting on byte 128 of my Global Memory



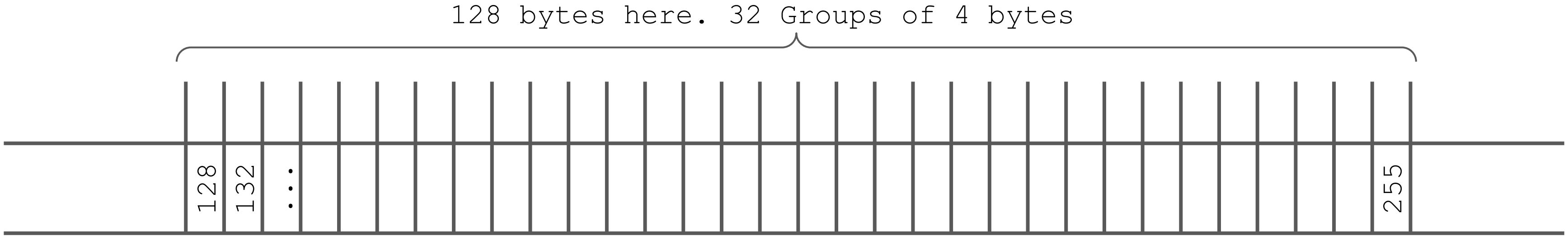
```
__device__ void add1(int* a, int vector_size) {
     id = blockIdx.x*blockDim + threadIdx.x;

     if (id<vector_size)
          a[id]=a[id]+1;
}

int main() {
     // do setup

     add1<<<4,256>>>(dev_a,vector_size);

     // do cleanup
}
```



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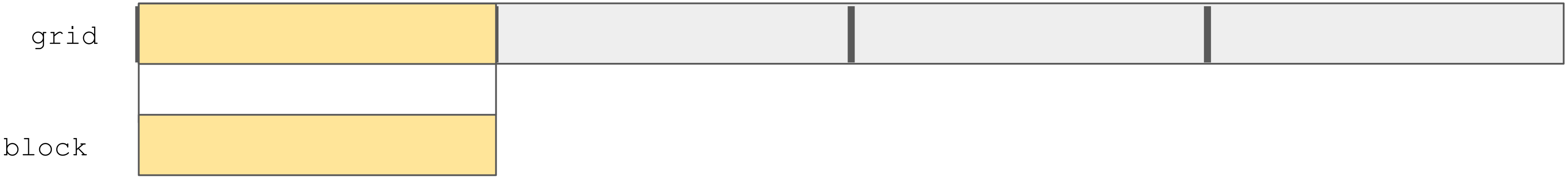
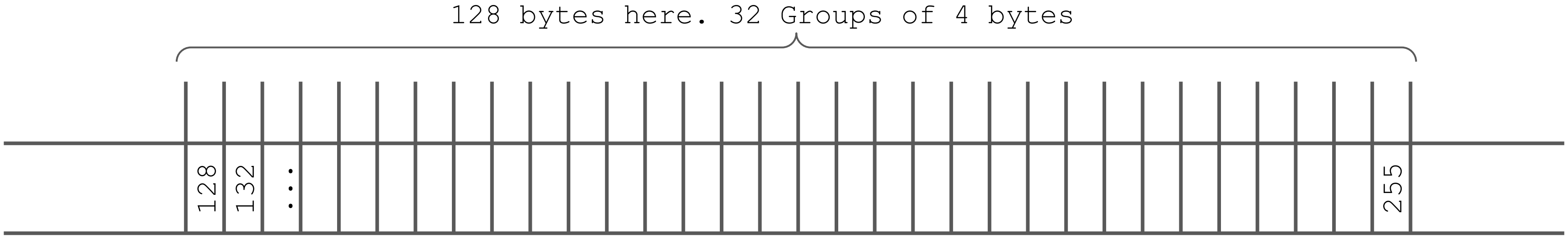




128 bytes here. 32 Groups of 4 bytes

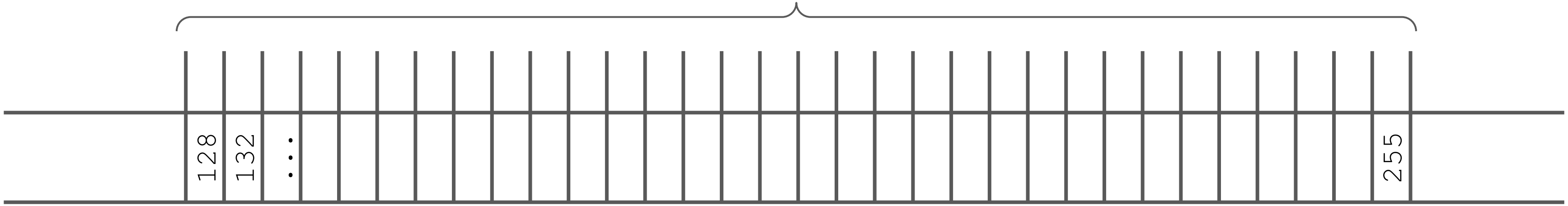
```
int main() {
     // do setup

     add1<<<4,256>>>(dev_a,vector_size);

     // do cleanup
}
```

… block ...

128 bytes here. 32 Groups of 4 bytes

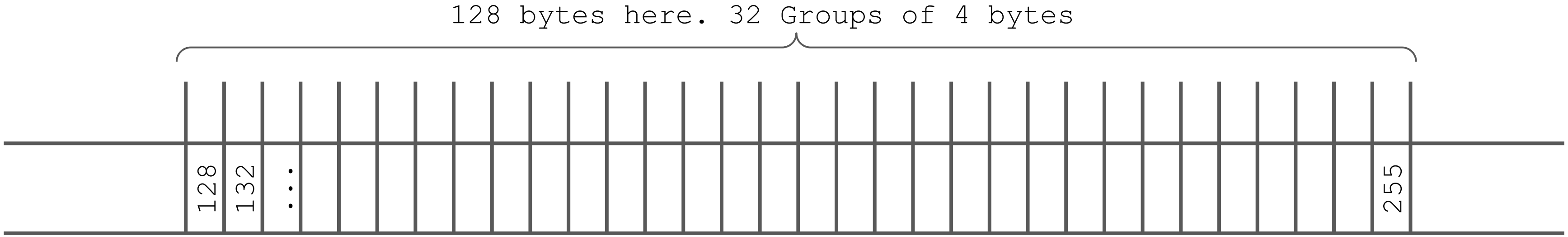


```
int main() {
     // do setup

     add1<<<4,256>>>(dev_a,vector_size);

     // do cleanup
}
```

…   block with 256/32 warps   ...

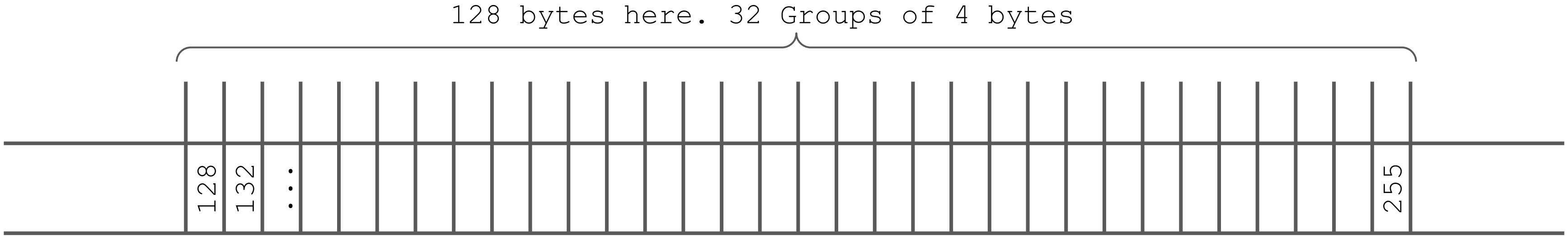


```
int main() {
     // do setup

     add1<<<4,256>>>(dev_a,vector_size);

     // do cleanup
}
```

… block with 8 warps ...



128 bytes here. 32 Groups of 4 bytes

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int main() {
     // do setup

     add1<<<4,256>>>(dev_a,vector_size);

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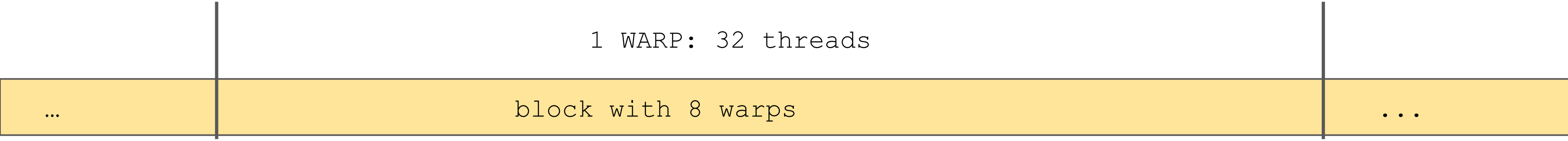
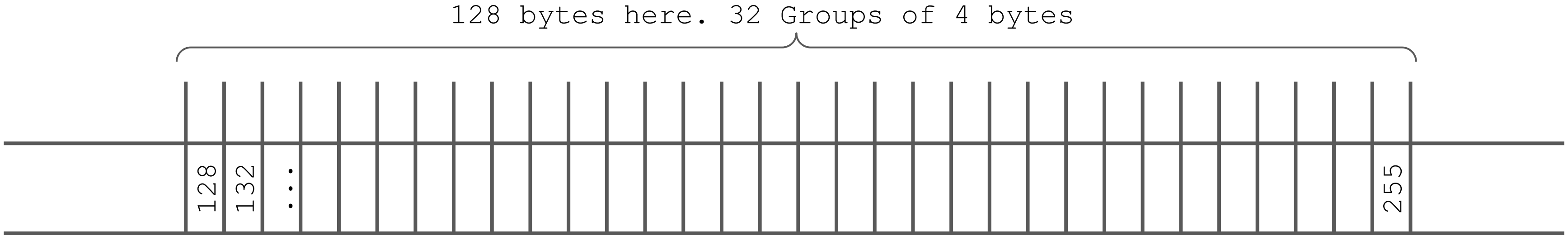


1 WARP: 32 threads



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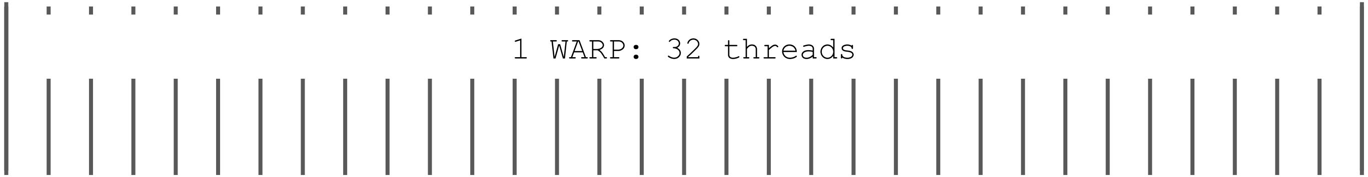
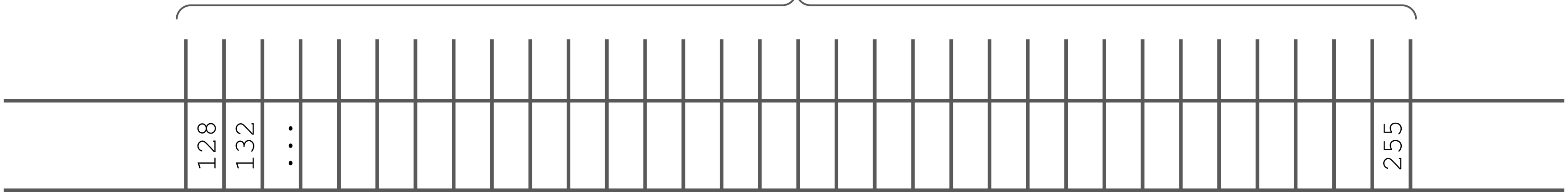


1 WARP: 32 threads

128 bytes here. 32 Groups of 4 bytes

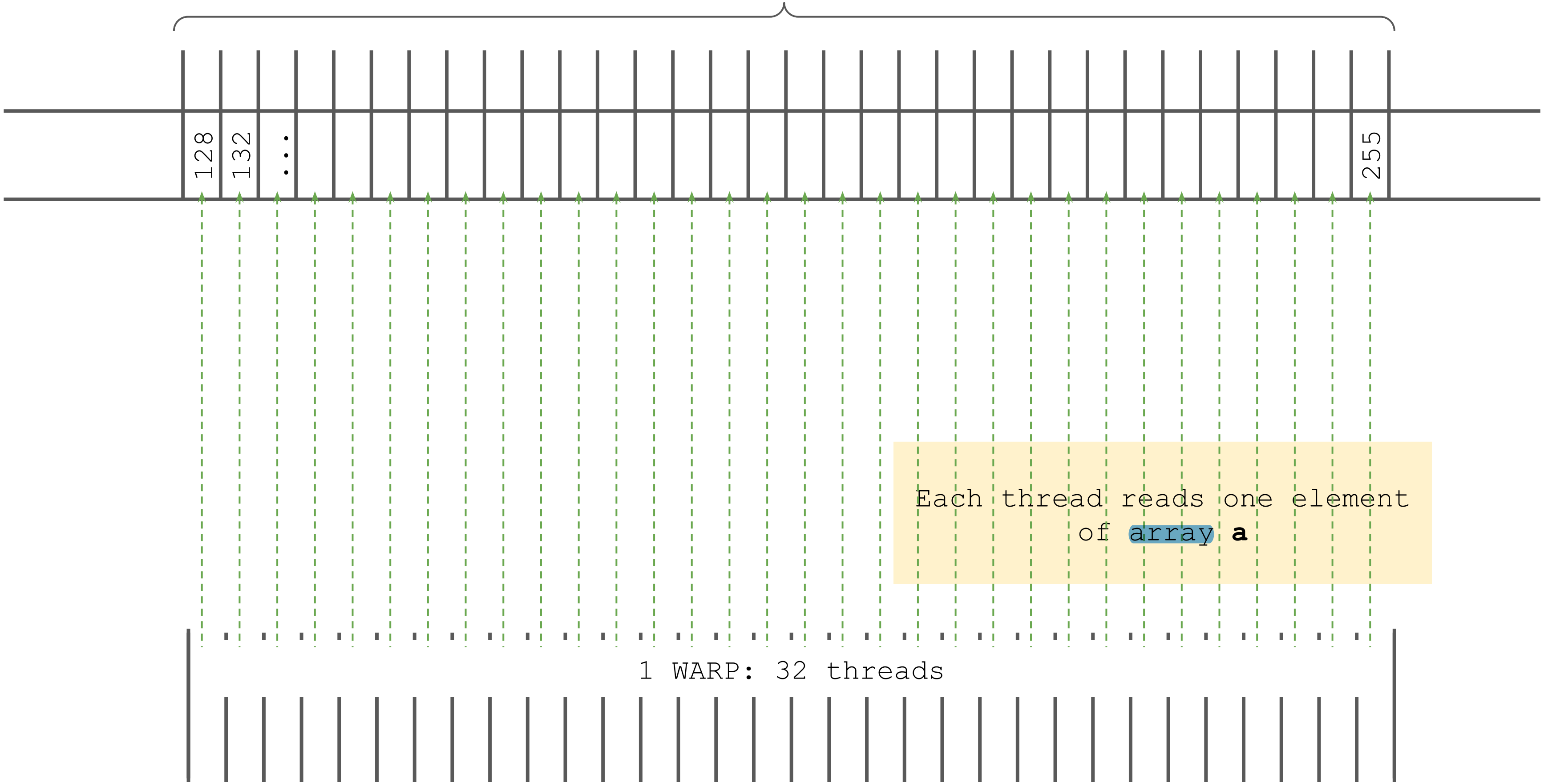


```
__device__ void add1(int* a, int vector_size) {
     id = blockIdx.x*blockDim + threadIdx.x;

     if (id<vector_size)
          a[id]=a[id]+1;
}
```

Each thread reads one element of array **a**

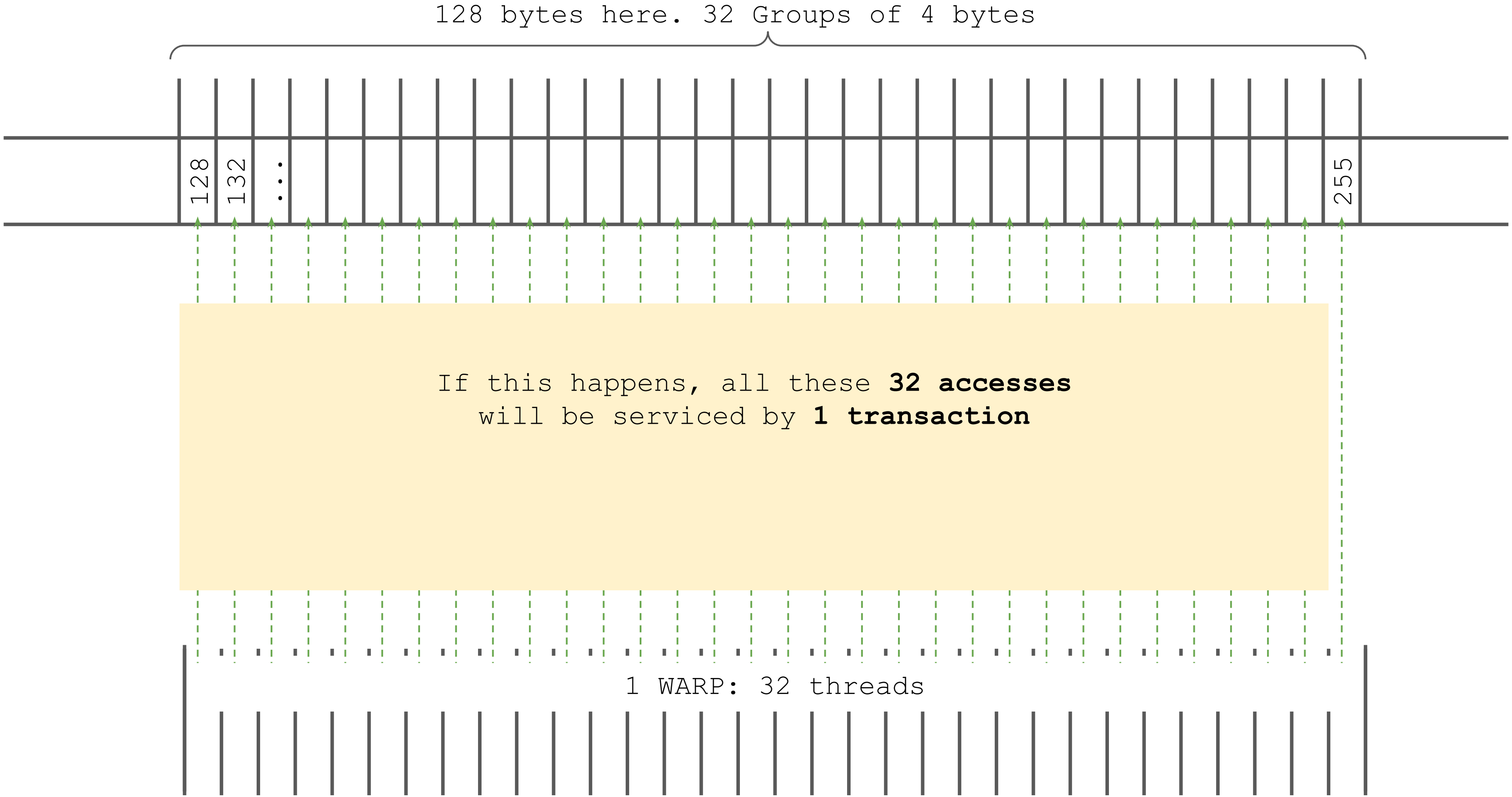
1 WARP: 32 threads



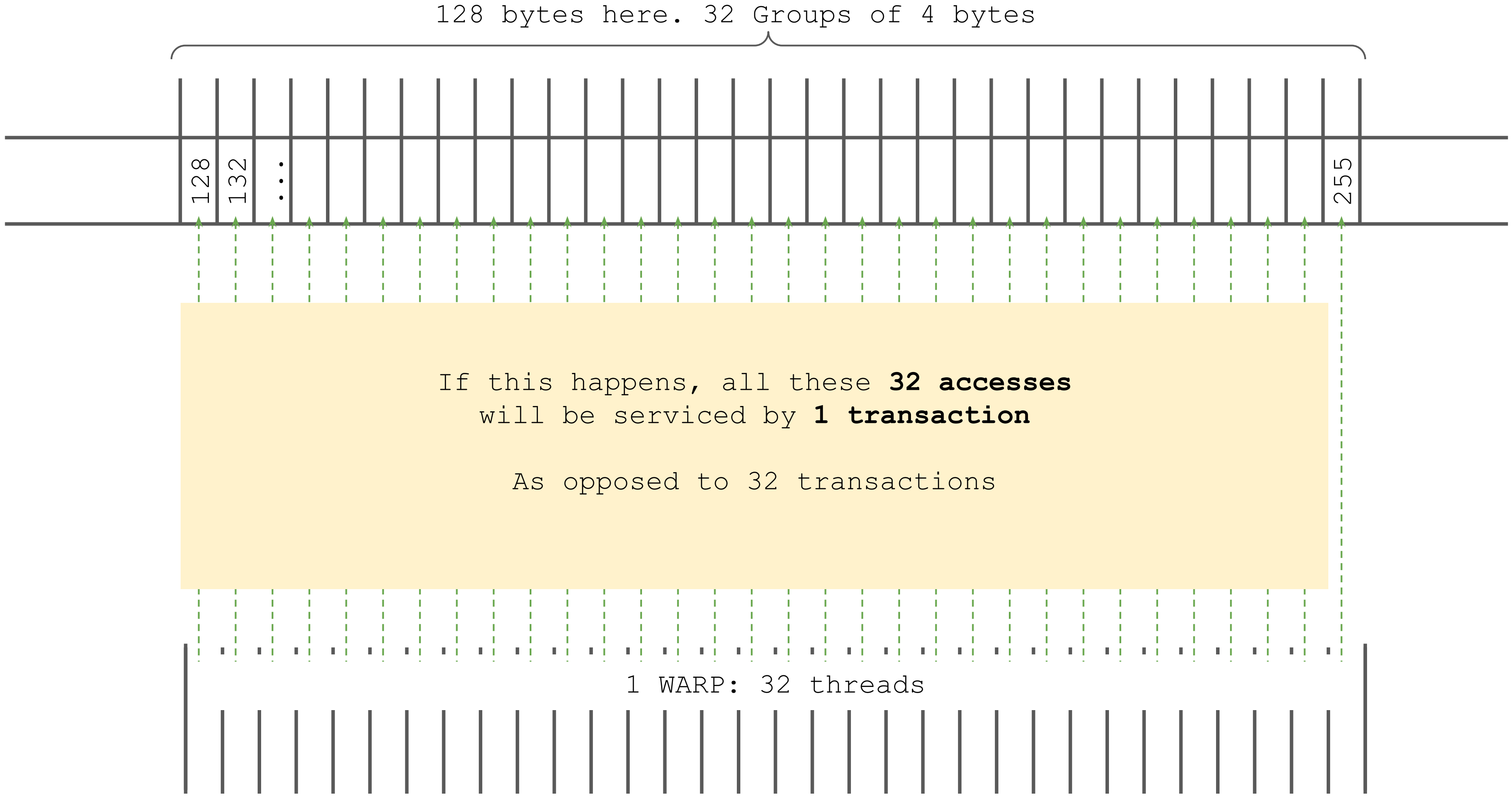
128 bytes here. 32 Groups of 4 bytes

Each thread reads one element of array **a**

1 WARP: 32 threads

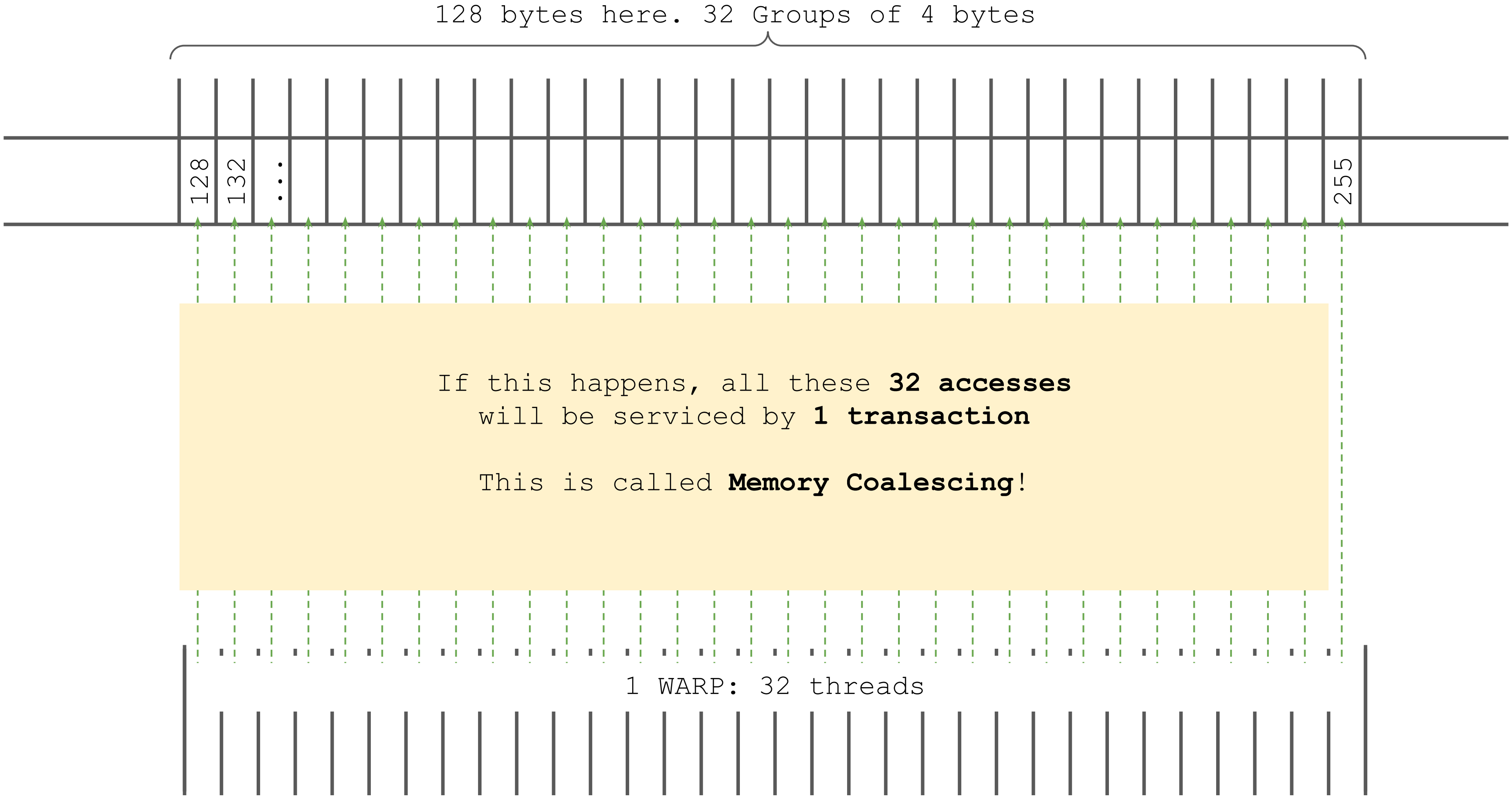


If this happens, all these **32 accesses** will be serviced by **1 transaction**



If this happens, all these **32 accesses** will be serviced by **1 transaction**

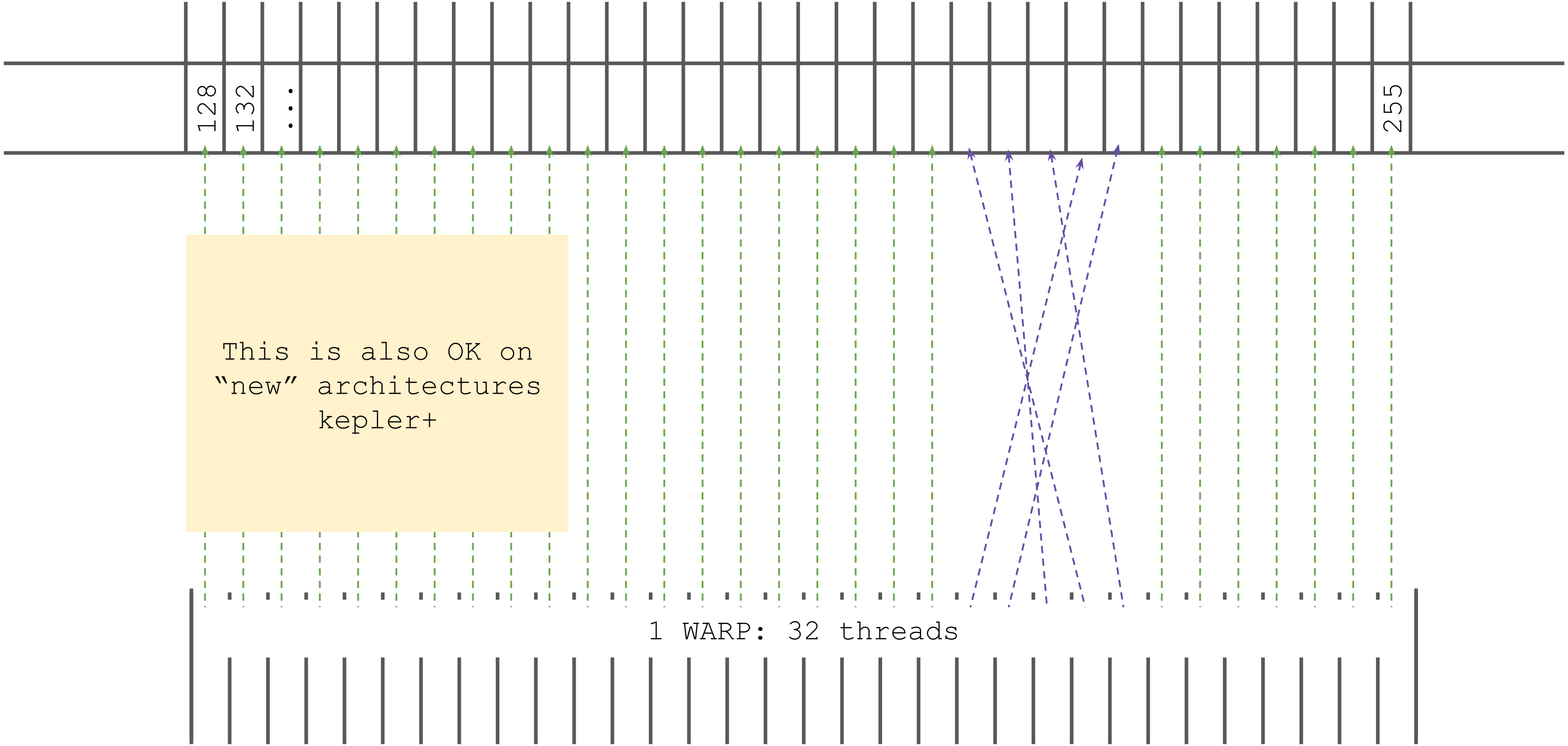
As opposed to 32 transactions



If this happens, all these **32 accesses** will be serviced by **1 transaction**

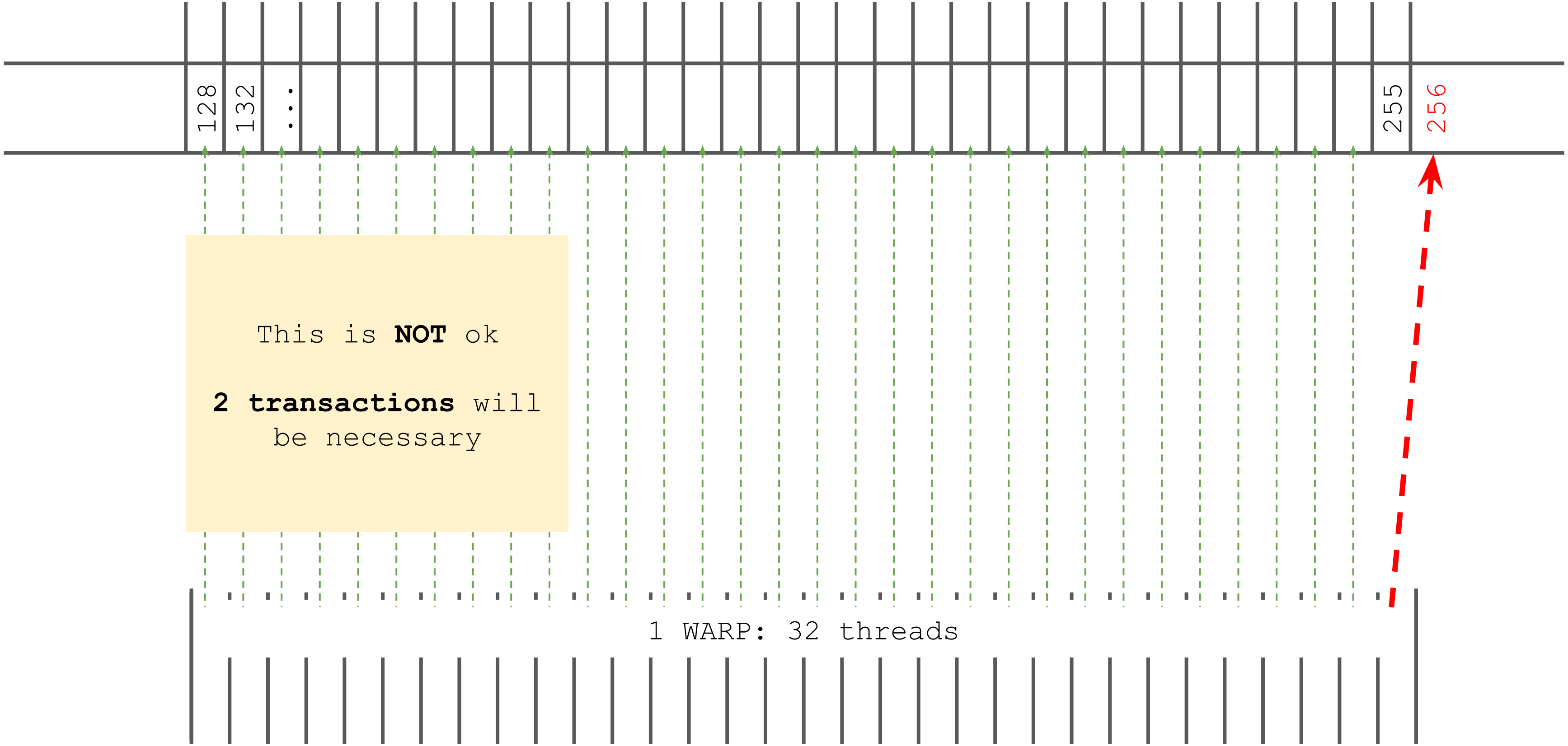
This is called **Memory Coalescing**!

Another kernel… that has some non-contiguous access based on tid



This is also OK on "new" architectures kepler+

Yet Another kernel… that has some non-contiguous access based on tid



This is **NOT** ok

2 transactions will be necessary

In your lab today!

```
Typedef struct myCoordinates {
     int x;
     int y;
     int z;
} Coordinates;


int main () {
     // do stuff

     coordinates * a = malloc(sizeof(Coordinates)*vector_size);

     // do more stuff
}
```

In your lab today!

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Typedef struct myCoordinates {
     int x;
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int main () {
     // do stuff

     coordinates * a = malloc(sizeof(Coordinates)*vector_size);

     // do more stuff
}
```

Size of 3 integers:
12 bytes

In your lab today!

```
Typedef struct myCoordinates {
     int x;
     int y;
     int z;
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int main () {
     // do stuff

     coordinates * a = malloc(sizeof(Coordinates)*vector_size);

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}
```

In your lab today!

```
Typedef struct myCoordinates {
     int x;
     int y;
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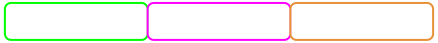
} Coordinates;


int main () {
     // do stuff

     coordinates * a = malloc(sizeof(Coordinates)*vector_size);

     // do more stuff
}
```

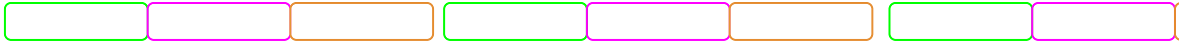
In memory 1 Coordinates object would look like this



In your lab today!

```
Typedef struct myCoordinates {
     int x;
     int y;
     int z;
} Coordinates;
```

In memory Several Coordinates object would look like this



```
int main () {
     // do stuff

     coordinates * a = malloc(sizeof(Coordinates)*vector_size);

     // do more stuff
}
```

In your lab today!

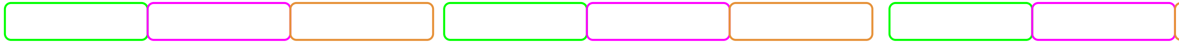
```
Typedef struct myCoordinates {
     int x;
     int y;
     int z;
} Coordinates;


int main () {
     // do stuff

     coordinates * a = malloc(sizeof(Coordinates)*vector_size);

     // do more stuff
}
```

So, accessing only **x (the greens)** would be a strided access



In your lab today!

```
Typedef struct myCoordinates {
     int x;
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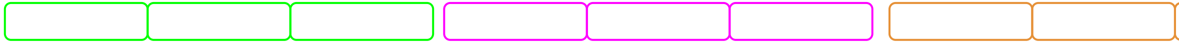
} Coordinates;
```

What we want is:



```
int main () {
     // do stuff

     coordinates * a = malloc(sizeof(Coordinates)*vector_size);

     // do more stuff
}
```

Good luck! ¯_(ツ)_/¯