Advanced Operating Systems
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Cross ring data move

1. Segmentation based protection breaks in data move
2. Kernel level actual data move facilities
3. Kernel level service replication

memcpy vs kernel internals

- ➢ Data move between user and kernel level buffers cannot rely on base buffer-management implementations such as memcpy()
- ➢ The reasons are:
  - ✓ ring based protection
  - ✓ segmentation based addressing
- ➢ Particularly, segments that are mapped to the same base are fully accessible while running at ring 0
  - ✓ Check and resolution of discrepancies needs to be carried out at run-time

User/kernel level data move (i)

```
unsigned long copy_from_user(void *to, const
  void *from, unsigned long n)
```

Copies n bytes from the user address(from) to the kernel address space(to).

```
unsigned long copy_to_user(void *to, const void
  *from, unsigned long n)
```

Copies n bytes from the kernel address(from) to the user address space(to).

```
void get_user(void *to, void *from)
```

Copies an integer value from userspace (from) to kernel space (to).

```
void put_user(void *from, void *to)
```

Copies an integer value from kernel space (from) to userspace (to).

User/kernel level data move (ii)

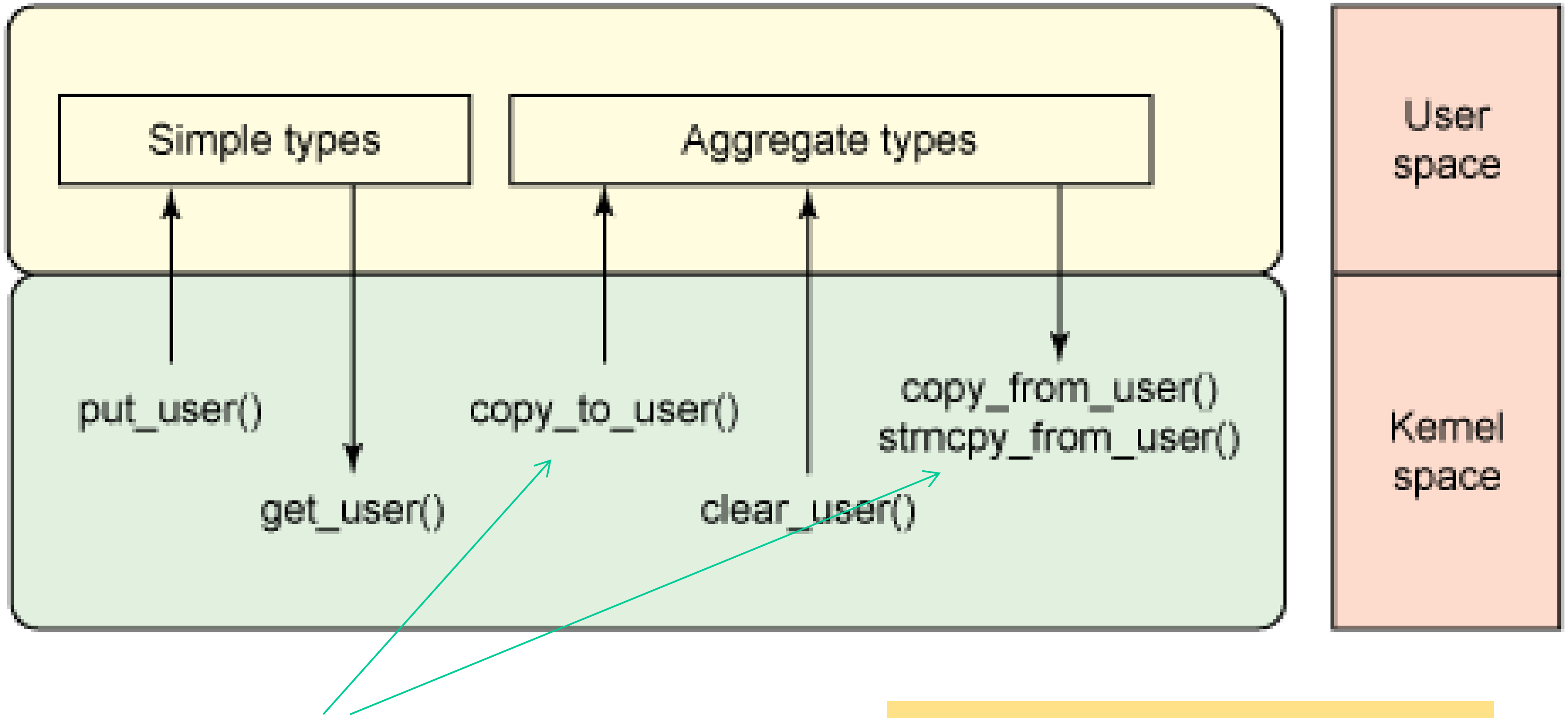
```
long strncpy_from_user(char *dst, const char
  *src, long count)
```

Copies a null terminated string of at most count bytes long from userspace (src) to kernel space (dst)

```
int access_ok(int type, unsigned long addr,
  unsigned long size)
```

Returns nonzero if the userspace block of memory is valid and zero otherwise

A scheme



These functions return the residuals (bytes not managed)

Most of them ground on `access_ok()`

The actual copy operation may lead the thread to sleep (we will be back to this issue when talking of contexts)

Main tasks

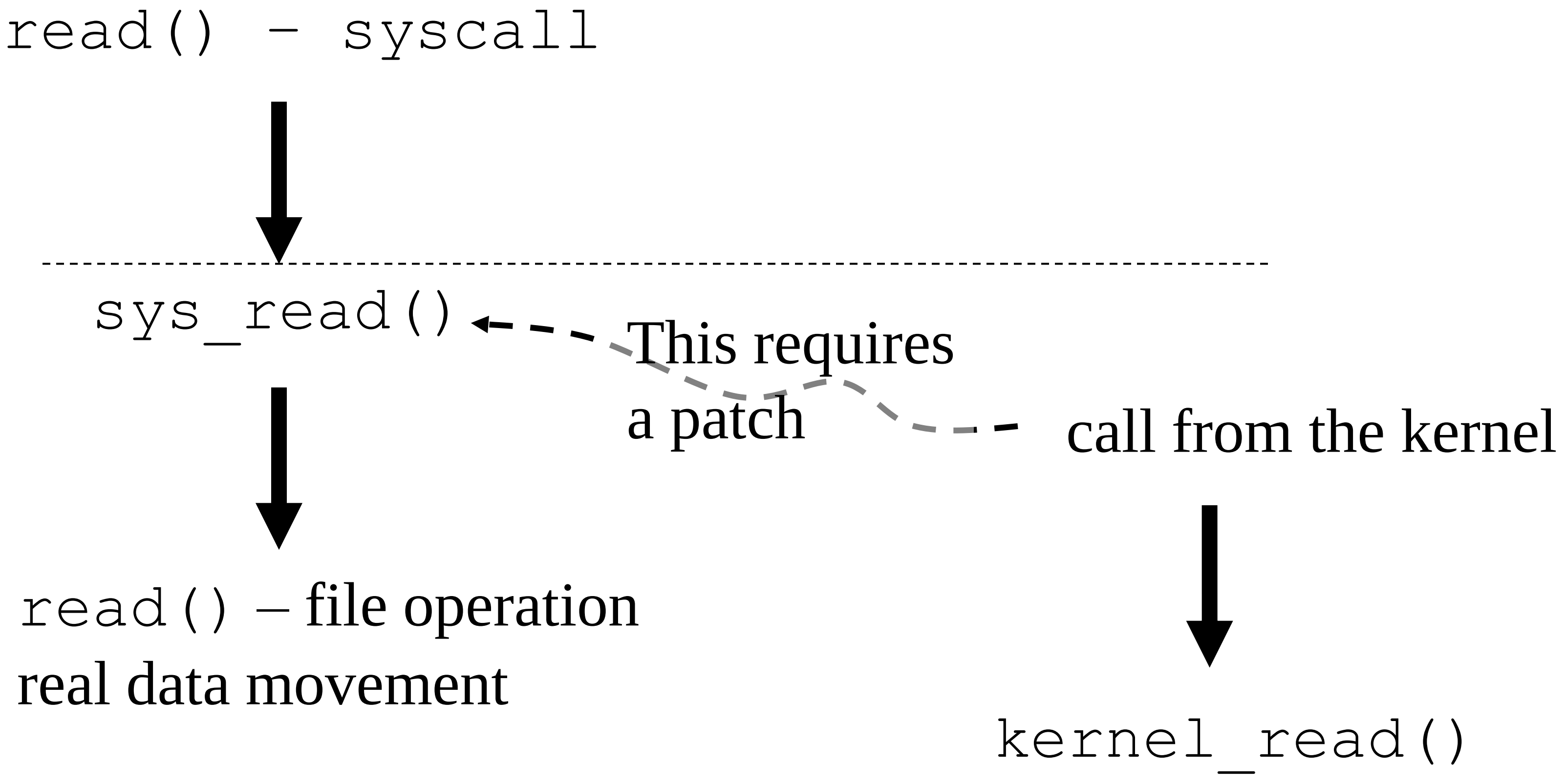
- Segment fixup (if segmentation takes a real role in the composition of the addresses)
- Check on address ranges related to user level
  - ✓ The actual depth of check may depend on the specific implementation (namely on the kernel version)
  - ✓ E.g., the process memory map might be checked or not
- **Note:** associating physical to virtual memory is demanded to the page-fault handler
  - ✓ Performance impact due to (possible) non-atomicity while finalizing the handling

Service redundancy approaches

- Check e fixup are required only in case we need to link activities across different privilege levels within the ring model (as when calling system calls)
- Particularly, this occurs when the execution semantic crosses the boundaries of individual segments
- Bypassing check e fixup when no crossing of segment boundaries occurs takes place via “service redundancy” (for performance reasons)
- The kernel layer entails an internal API for executing activities that are typically triggered when running in user mode

Classical examples

- `kernel_read()` is a redundancy for `read()`
- `kernel_write()` is a redundancy for `write()`



`read() – syscall`

`sys_read()`

This requires a patch

call from the kernel

`read()` – file operation
real data movement

`kernel_read()`