Paper “Duality”

• Brief history of Mach:
  – 1975 U-Rochester: “Rochester Intelligent Gateway” (modular OS + message passing)
  – 1981 CMU: “Accent” (message passing OS)
  – 1984 CMU: “Mach” (compatible with Unix, threads, IPC, multiprocessor, VM)
  – Convoluted rest of history; part one of more interesting tidbits is 4.3BSD with core parts of kernel replaced with Mach yielded NeXTSTEP, which led to OS X
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- Message interface: app can “control” OS
- Mach: object-oriented interface, distributed computing, multiprocessing, portability, UNIX compatibility, UNIX performance
- **Ports**: kernel-provided IPC mechanism; unidirectional, kernel-protected **channel** (n send endpoints, 1 receive endpoint).

### Ports:

- Kernel-provided IPC mechanism; unidirectional, kernel-protected channel (n send endpoints, 1 receive endpoint).

### Mach IPC messages:

- Data objects exchanged between threads (and user-level & kernel-level)
- Either inline data or out-of-line (OOL) data; latter: kernel reserves region in receiver’s virtual address space by mapping pages (copy-on-write)
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- Memory objects:
  - Virtual memory: map process address onto memory objects; accessed via messages
  - Separate machine-dependent from machine-independent components:
    - pmap (kernel; manage MMU)
    - machine-independent kernel code
    - memory manager (user-level)
  - Memory map: ordered, linked list of references to memory objects (“files”)

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- Message structure
- msg_send, msg_receive, msg_rpc
- Default ports and custom ports
- VM operations
- External memory management