ELEC 875
Design Recovery
and
Automated Evolution

Architecture
Analysis

Next Week

Bull, R.I.; Trevors, A.; Malton, A.J.; Godfrey, M.W. "Semantic grep: regular expressions + relational abstraction" *9th Working Conference on Reverse Engineering(WCRE 2002)*, October, 2002, Richmond, Virginia, pp. 267- 276.

Advanced TXL

Bowman, Holt, Brewster

- Some Systems do not have documented system architecture
  - ◊ Extract the system Architecture
- Problems keeping documented architecture up to date
  - ◊ Automation?

Linux

- 10 KLOC in 1991 to 1.5MLOC in 1998
  - ◊ doubled every year

- Linux Kernel - 800 KLOC
  - ◊ documented at individual system level
  - ◊ no architectural documentation
  - ◊ good guinea pig

Architecture

- Conceptual architecture
  - ◊ How developers think about the system
  - ◊ only the meaningful links and dependencies
  - ◊ Component responsibilities
  - ◊ Component interactions
- Activities
  - ◊ Capture Functionality
  - ◊ Capture Properties
  - ◊ Constraints

Architecture

- Concrete Architecture
  - ◊ The “real” architecture
  - ◊ extracted by some set of tools.
  - ◊ Contains extra links required by the implementation

- Neither architecture is documented for Linux

Architecture Change

- Architecture Erosion
  - ◊ Conceptual Violations

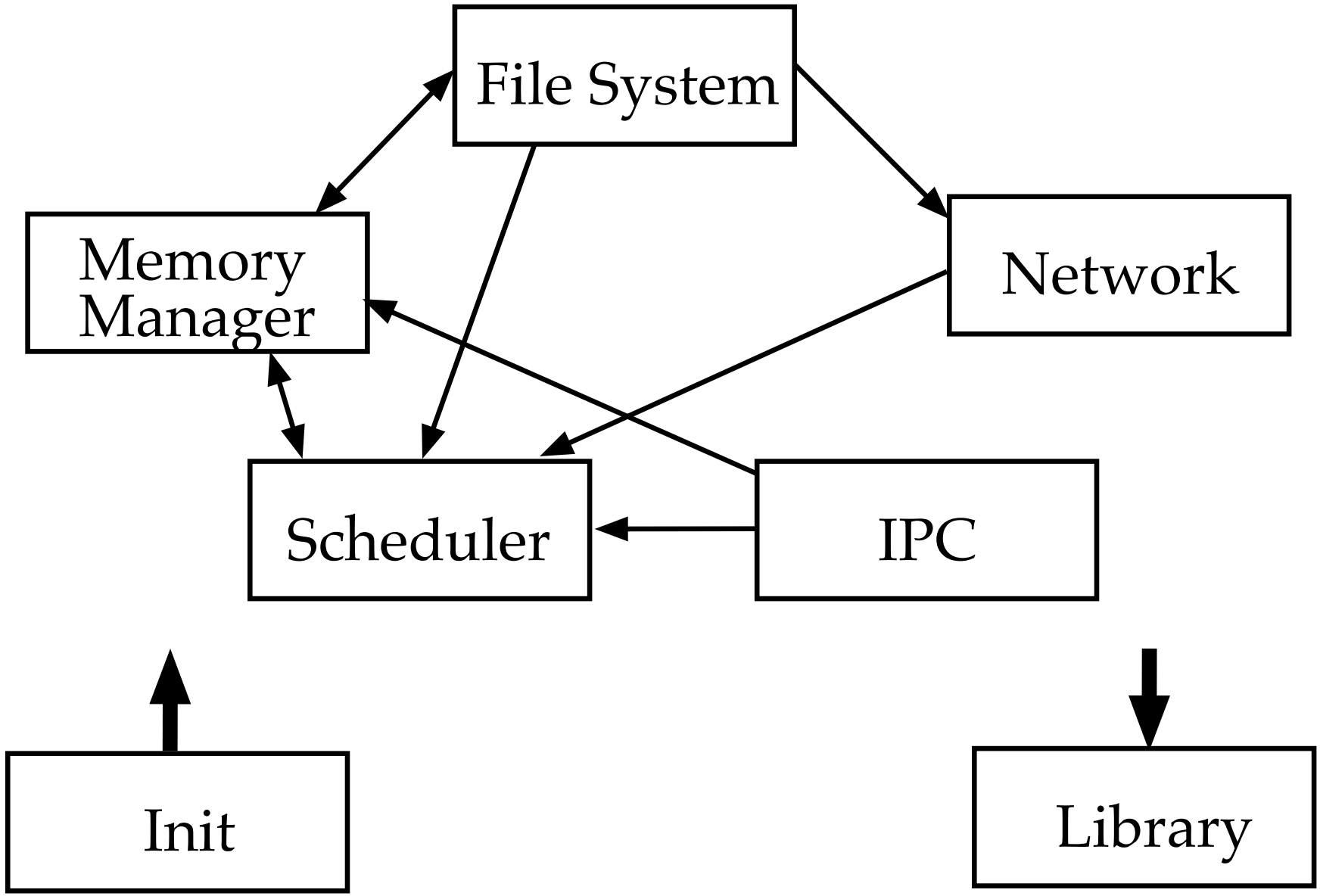
- Architecture Drift
  - ◊ Concrete architecture drifts away from conceptual architecture

Linux Conceptual Architecture

- Read Documentation
  - ◊ No conceptual architecture documentation?
  - ◊ Some architectural information spread in different documents
  - ◊ Some overview documentation
  - ◊ Knowledge of other Unix based architectures

  - Tunis, Hector

Linux Conceptual Architecture



File Conceptual Architecture

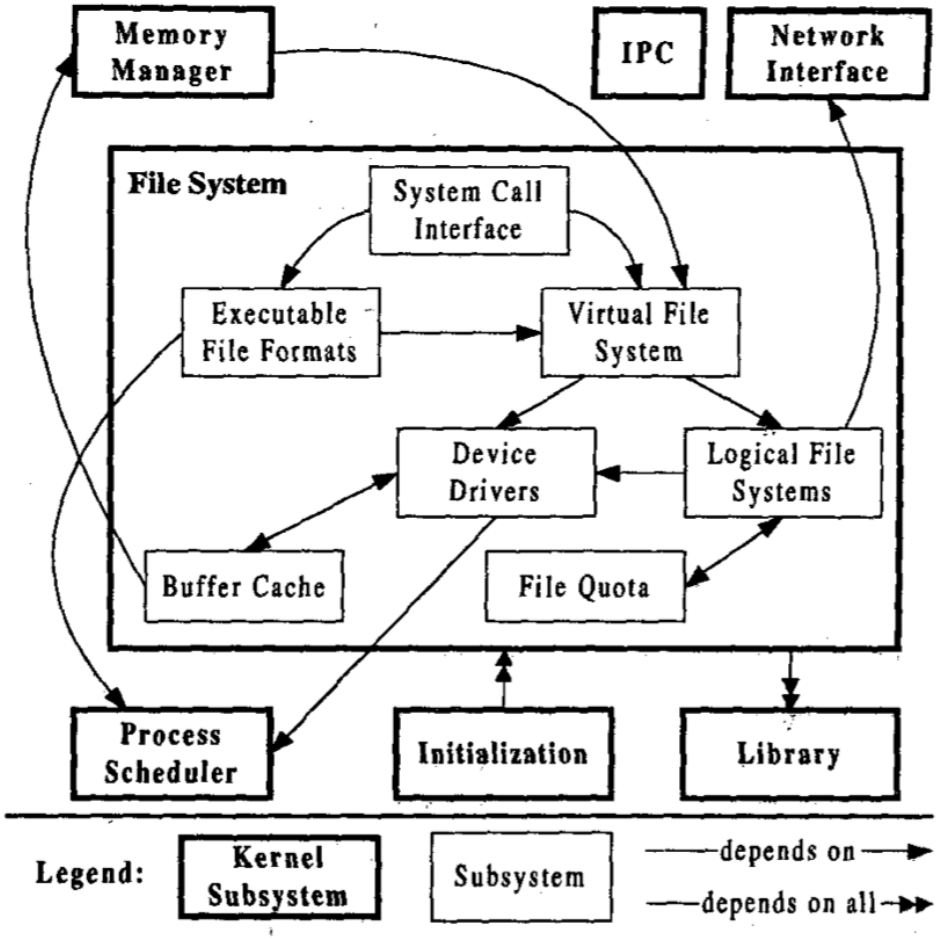


Figure 2: File System Conceptual Architecture

Linux Concrete Architecture

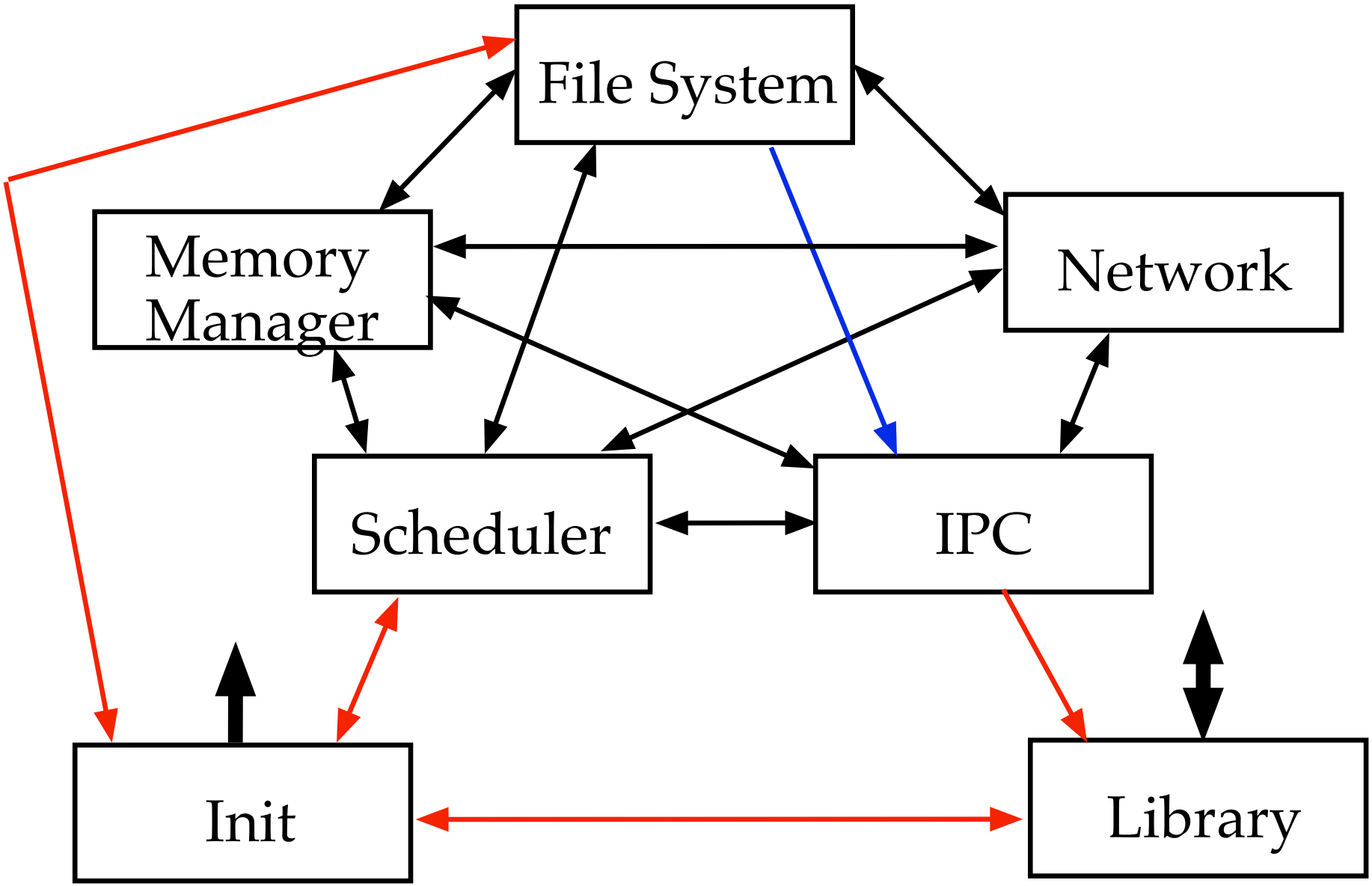
- Group source files based on directory structure, naming conventions, source code comments and source code examination
- Extract Relations between source files
- Lift relations between source files to relations between subsystems
- Convert to concrete architecture

Linux Extraction

- cfx - predecessor to cppx
  - ◊ function level extraction (Middle Model)
- grok used to turn:
  - relations between functions and functions
  - relations between functions and files

  >>>>>
  - relations between files
- Files manually assigned to subsystems
- grok used to *lift* relations from files to subsystems

Linux Concrete Architecture



File Concrete Architecture

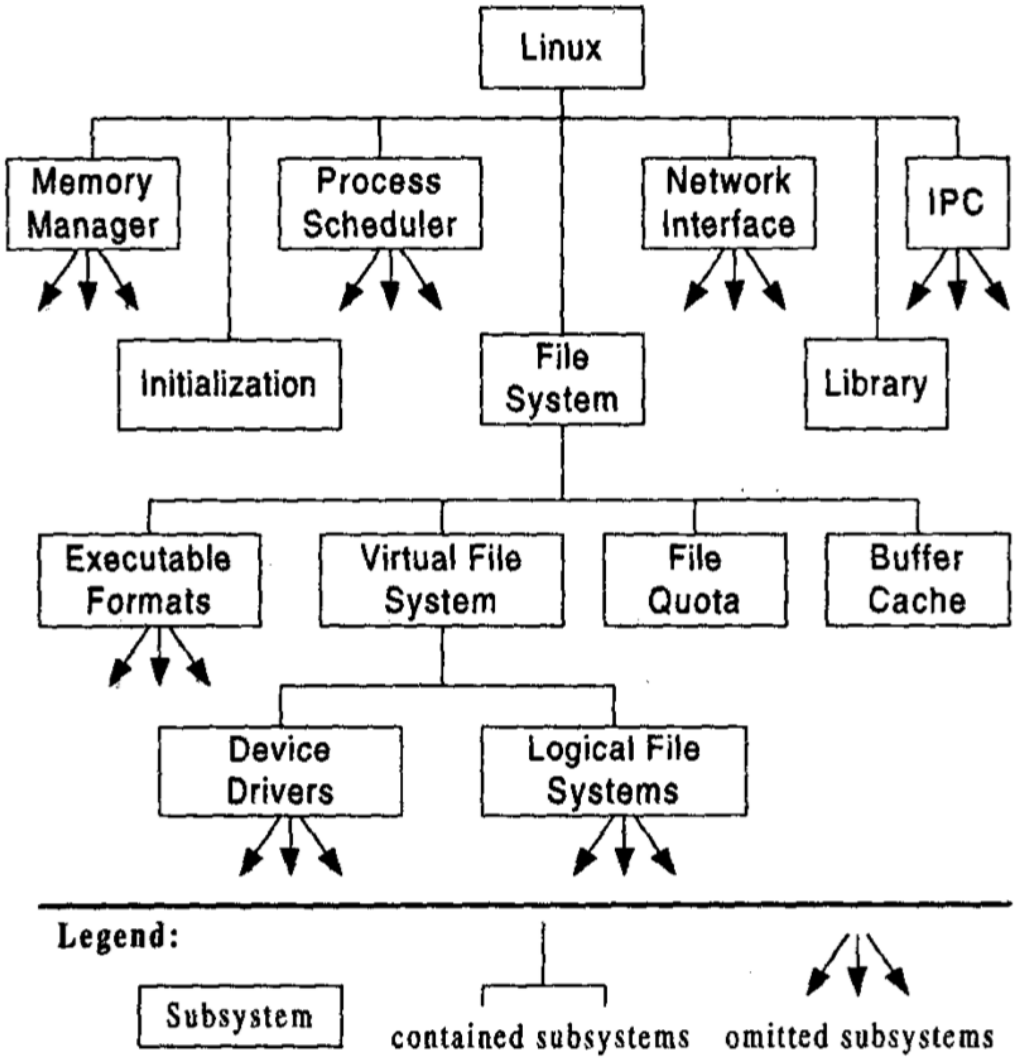


Figure 4: Partial Subsystem Hierarchy

File Concrete Architecture

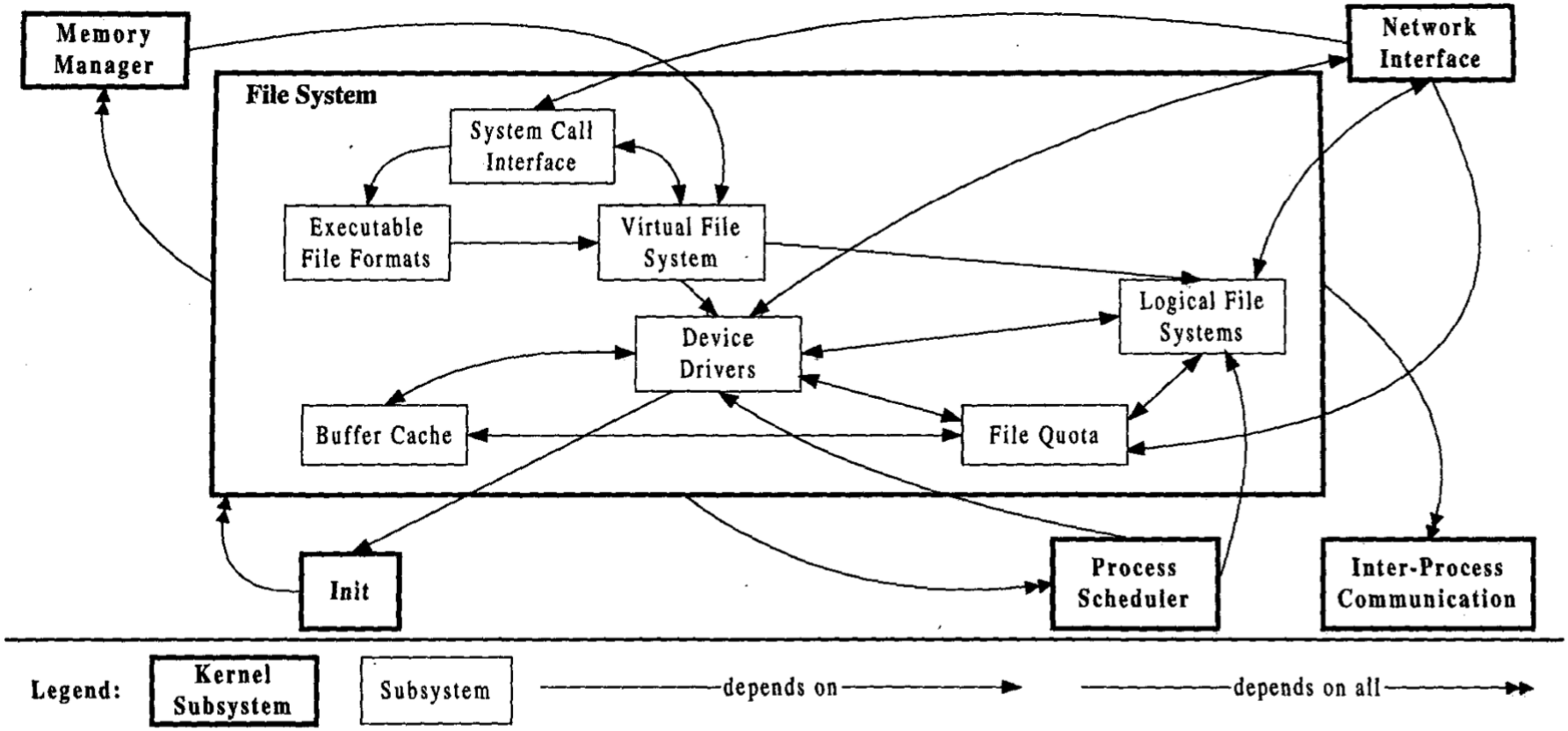


Figure 6: File System Concrete Architecture

MM Concrete Architecture

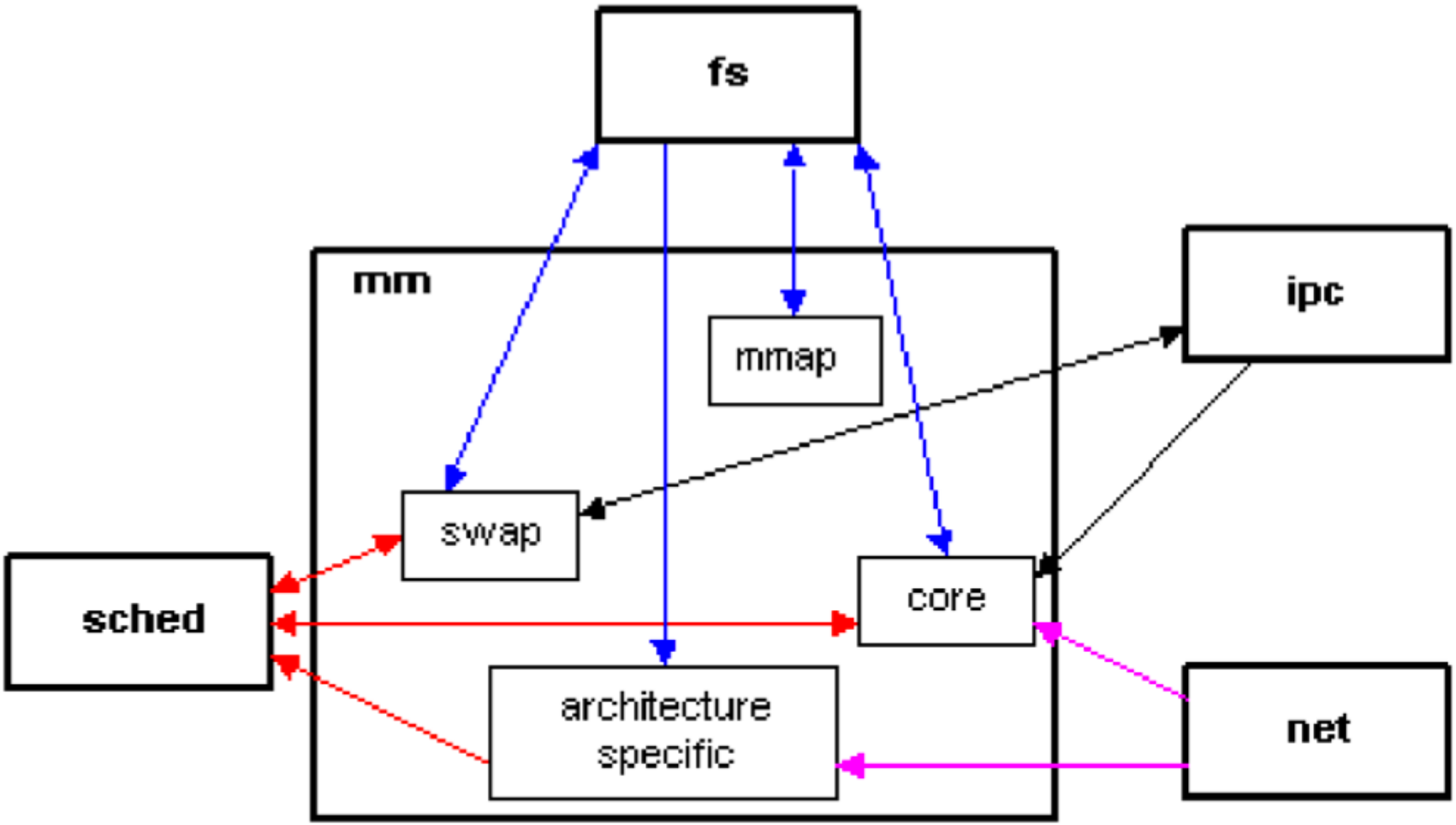


Figure 5: Memory Manager Dependencies

Linux Concrete Architecture

- Given that concrete architecture one would think that the linux implementers are horrible coders
- efficiency shortcuts
- expediency
- Debugging (process scheduler depends on file system) mislocation of printk (process -> library)
- Synchronization primitives in IPC
- differences at the subsystem level

What Did We Learn?

- Human Assistance Needed in Analysis
- Concrete Architecture Different from Conceptual
  - ◊ why
  - conceptual architecture incorrect
  - efficiency
  - expediency
  - unanticipated dependencies
  - differences in control flow
  - implementation language or environment constraints
  - some subsystems implemented everywhere!!