Software Performance Modeling of a Frame Relay Access Device

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GTE Internetworking
(work carried out at *Racal-Datacom*)

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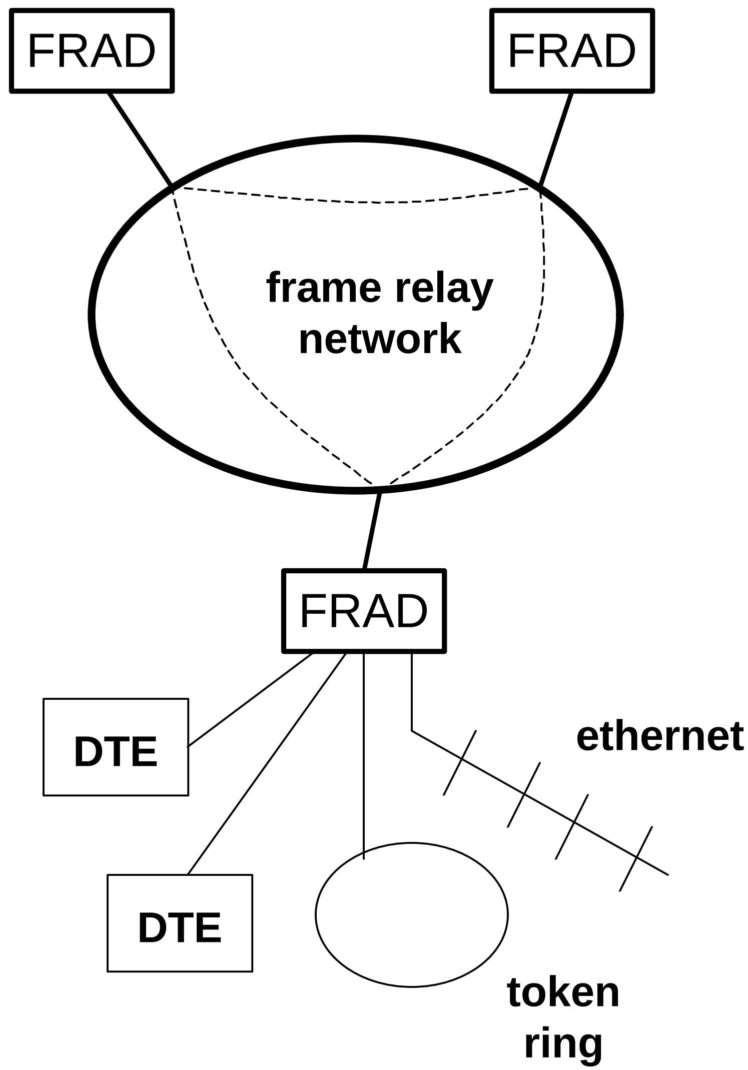
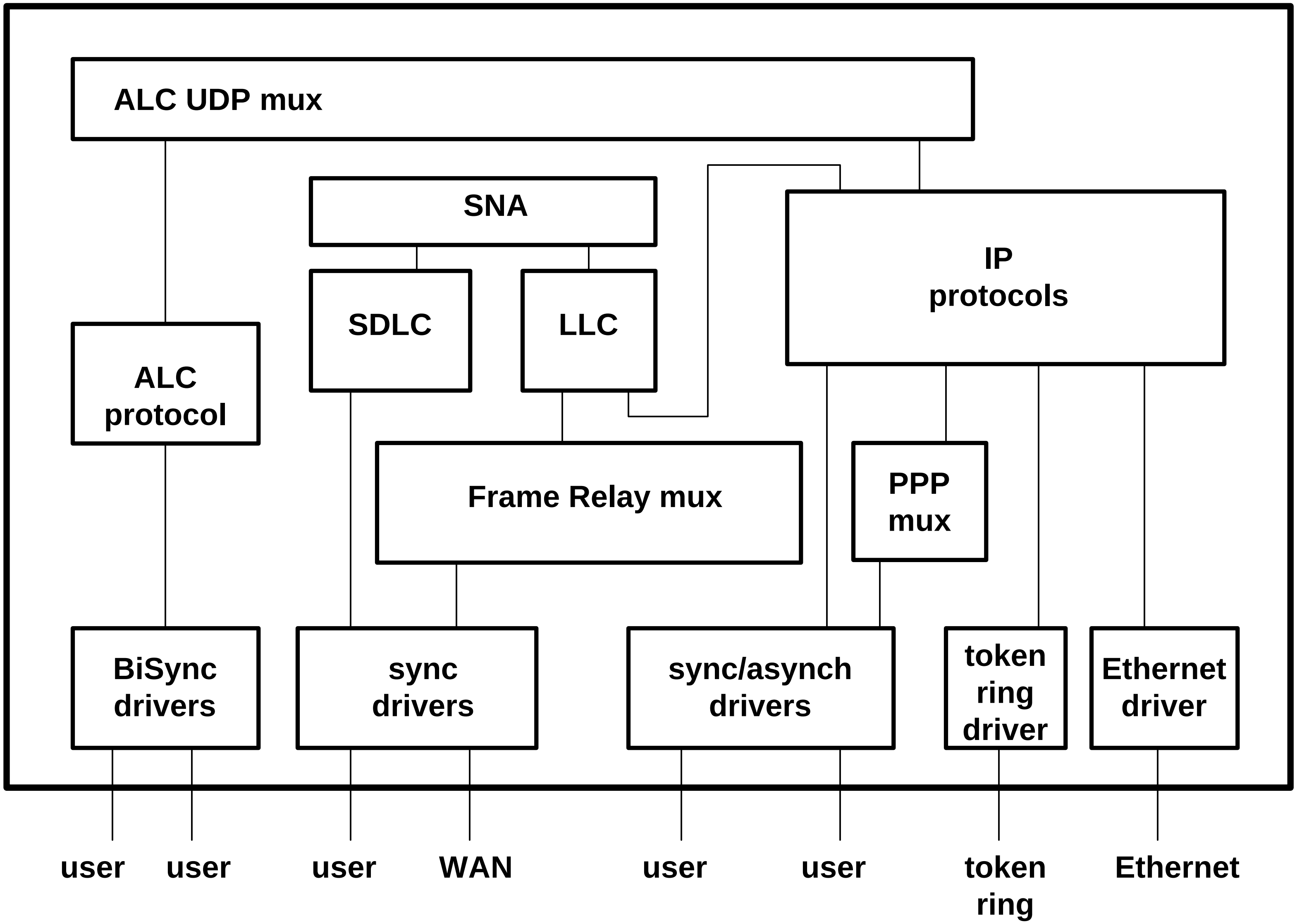
Frame Relay Network Access Device

- **Frame Relay Network**
  - **virtual-circuit service**
  - **connects remote sites**
  - **economical compared to a private leased-line network**

- **FRAD**
  - **interconnects LANs and DTEs to the frame relay network**
  - **a multi-protocol multi-function device**



Racal's *FastFrame 600*
FRAD Protocol Architecture



FastFrame 600 FRAD Software

- **Protocol Modules**
  - **standardized**
    - acquired from various vendors
  - **proprietary**
    - different software development groups

- **Protocol Integration with UNIX STREAMS Facilities**
  - **kernel routines for layered protocol software**
  - **modular architecture**
    - drivers, modules, multiplexors, queues
  - **simplifies development**
  - **reduces development time**

Need for Software Performance Modeling and Analysis

- **protocol modules developed by different groups**
- **performance of integrated system is unknown *a priori***
  - throughput, delay, burst handling
- **shortened time to market**
  - less time for performance measurement, re-design, tuning
- **performance 'disasters' at end of development cycle are costly**
- **real-time performance is of increasing importance** (e.g. voice/packet)
- **product requirements include performance**
- **need UP-FRONT analysis at product specification phase**
  - architectural choices, verify design for performance requirements, expose potential flaws
- **analysis at testing stage**
  - tool to help in parameter optimization
  - evaluate 'last-minute' changes

FRAD Performance Modeling and Analysis

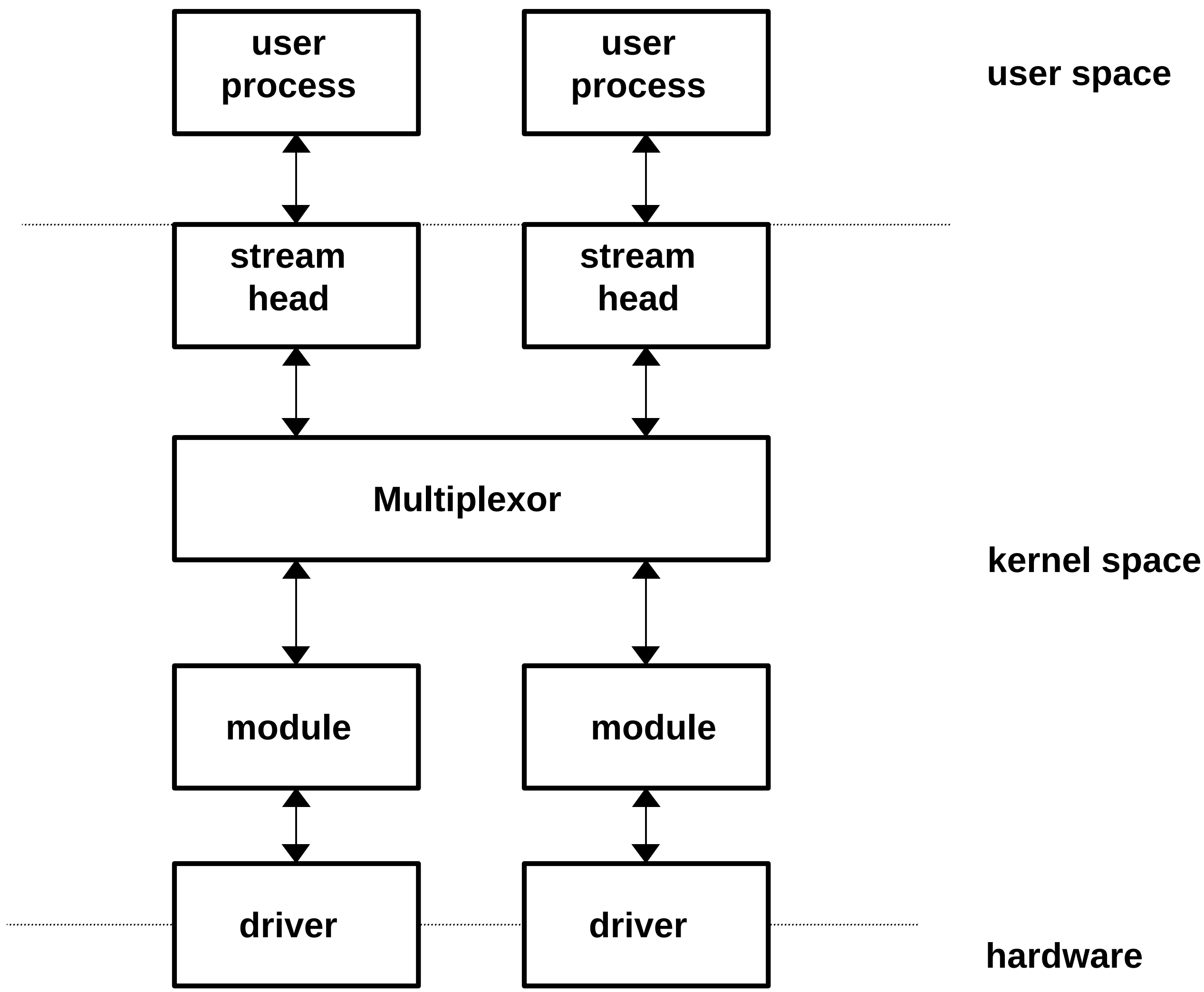
- We propose a software performance model for data-networking products based on STREAMS

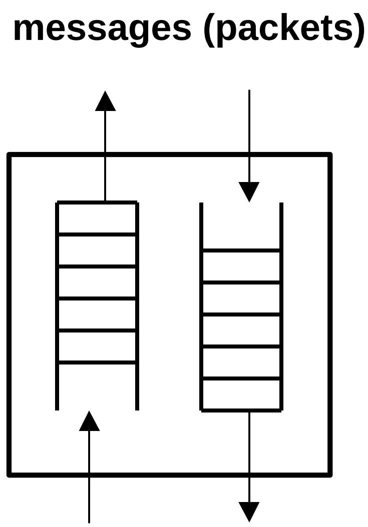
- UNIX STREAMS maps naturally into a queueing model
  - model focuses on data-transfer phase
  - exploit structure imposed by STREAMS

- service times (path-lengths) obtained from code measurements

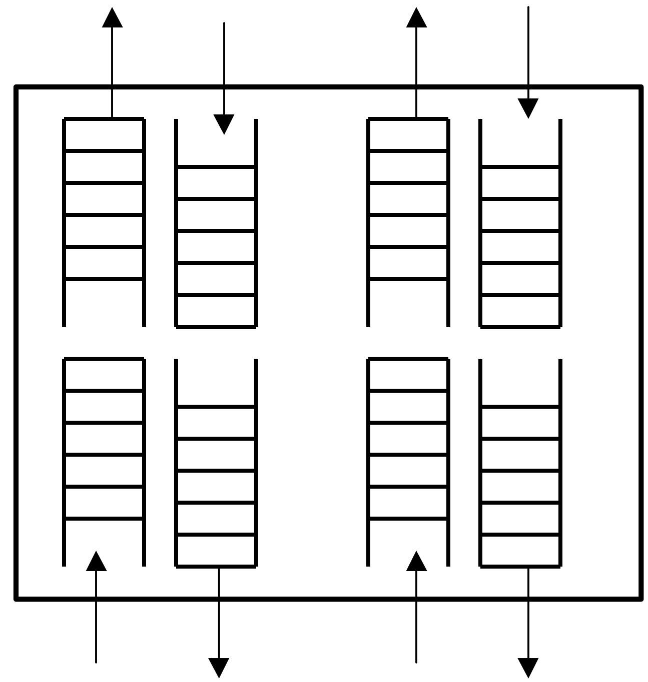
- analysis using simulation or analytical techniques

STREAMS Modeling





queues in a module



queues in a multiplexor

- **Message priorities in a STREAMS queue**
  - **normal messages**
  - **expedited messages (levels 1 to 255)**
  - **high-priority messages**
  - **FIFO scheduling within each priority band**

- **Message passing from one queue to another in STREAMS**
  - **involves kernel routines**
    - *putnext ( )*
    - *put ( )*
    - *putq ( )*
    - *service ( )*

(1) queue A service calls putnext

(2) putnext passes message to queue B put

(3) queue B put processes message

(4) put passes message to putq

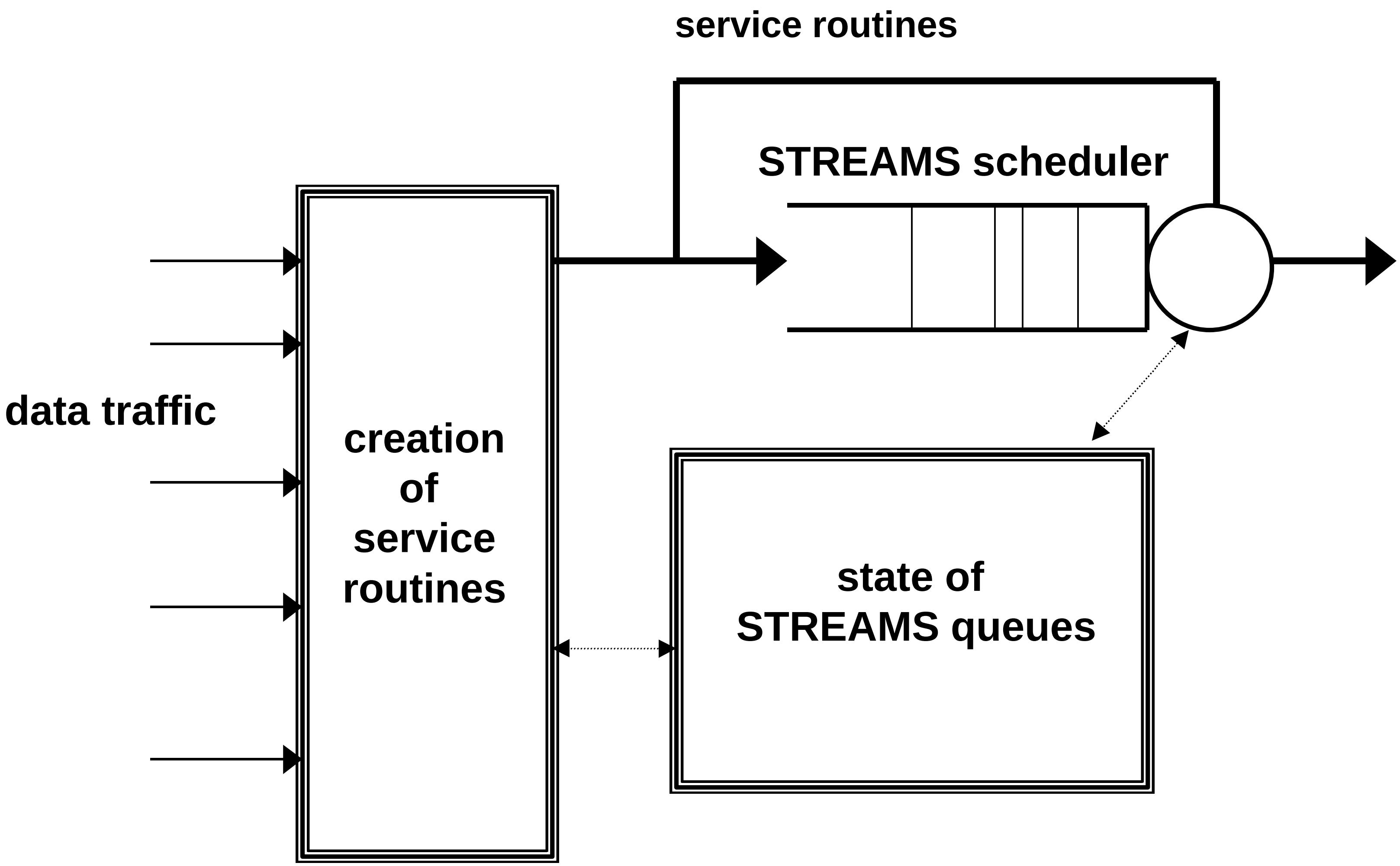
(5) putq places message on queue B

(6) putq schedules queue B service

- **Scheduling of Service Routines by STREAMS**
  - **service routines called by STREAMS scheduler**
  - **STREAMS scheduler is FIFO**
  - **STREAMS scheduler processes all messages on a queue when service routine is called**

- **Inter-Queue Flow Control in STREAMS**
  - **counter *q_count***
  - **high and low water marks**
  - **service routines “put to sleep” if flow control in force**
  - **service routines “woken up” when flow control removed**

State-Dependent FIFO Queueing Model



Model Analysis

- **Analytical**
  - difficult due to complex state-dependencies
  - possible to develop a simplified Markov chain model
  - a challenging performance analysis problem

- **Simulation**
  - simulation model implemented using OPNET Modeler
  - could automate building of OPNET model using OPNET EMA interface

Concluding Remarks

- **Software performance modeling and analysis is an essential for data-networking product development**
- **research needed for SPE of data-networking products**
- **automated tools are needed for SPE**
- **we proposed a queueing model for SPE of STREAMS-based data-networking products**