Liberouter: a PC-based IPv6 router

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Introduction

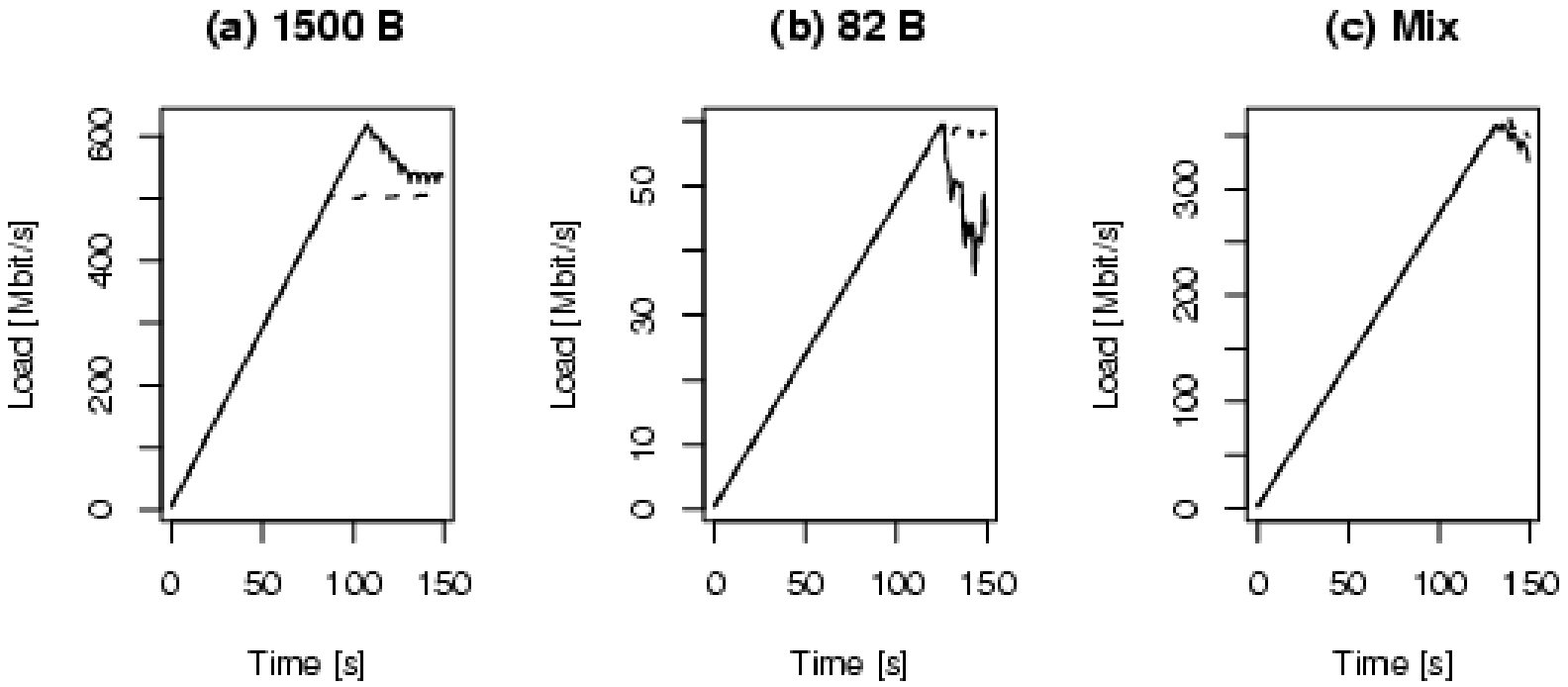
- Routers and routing – complex technology, interesting algorithms inside the black (blue, violet) boxes
- Liberouter: let's do it ourselves, as a truly open research project (open-source licenses)
- Flexible platform for network research, especially in IPv6
- Competitive solution for the network edge
- Special functions: encryption, monitoring, traffic generator
- Commodity PC with additional hardware, later as embedded systems
- Support from CESNET and 6NET

Software PC router

- In CESNET networks since early 1990s
- Operating systems: KA9Q, PC Route, *BSD, Linux
- Routing software: GateD, Zebra
- Excellent experience, still in use in some MANs, national IPv6 backbone, m6bone
- Limited forwarding performance (PCI and memory bus throughput, interrupt handling)
- Inconsistent configuration through init scripts and configuration files

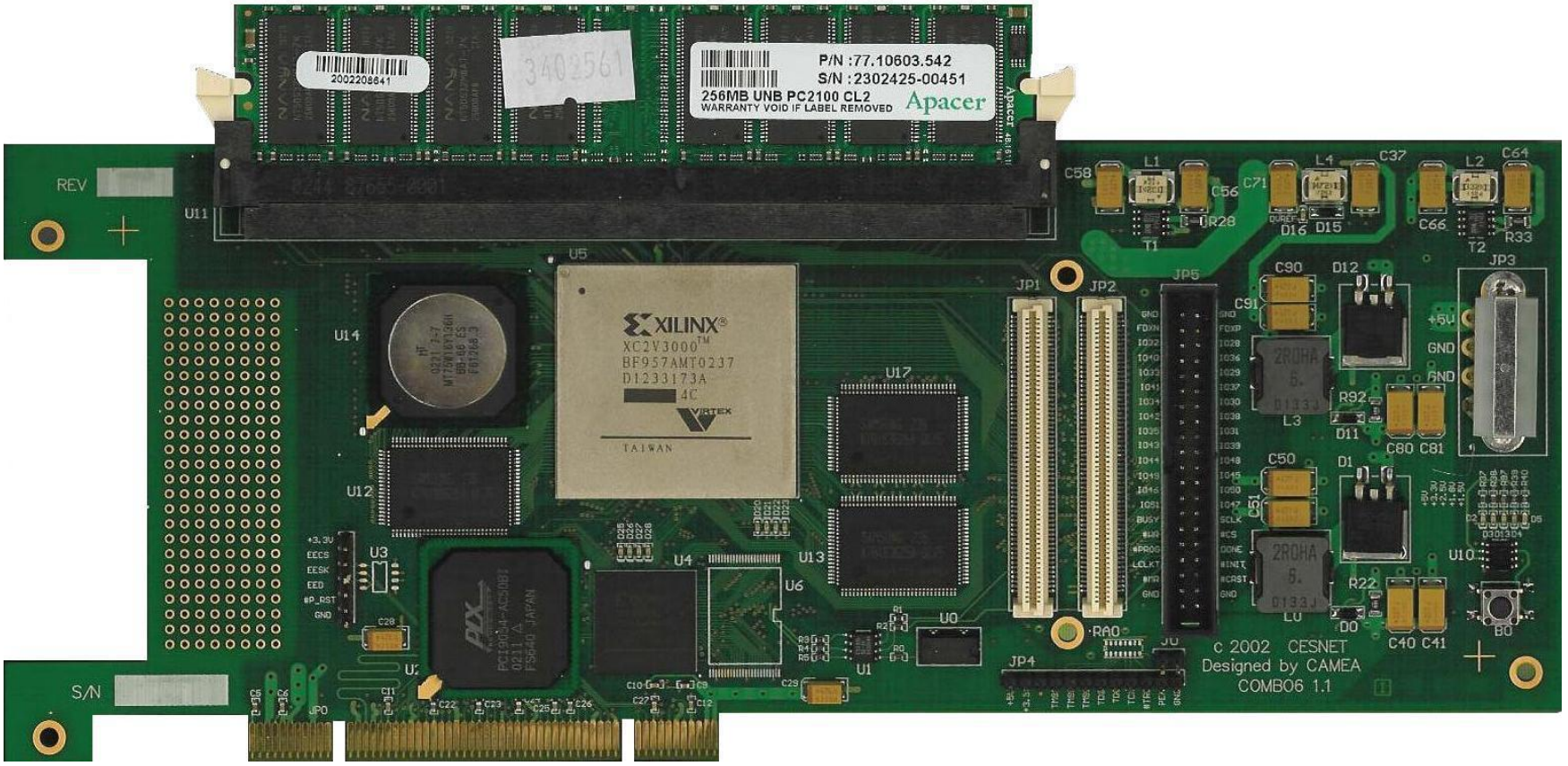
GE forwarding performance

PC/Linux (PCI 64/66) ——
Cisco 7500 - - -



- Dual-stack router with hardware acceleration:
  - Commodity PC with NetBSD or Linux
  - FPGA-based board: data plane in HW; control plane remains in SW
  - Throughput about 10 Gbps
  - Daughter interface cards (GE, 10GE, later POS)
- Powerful and user-friendly configuration system
  - XML-based configuration repository
  - Bidirectional translation between XML and native configurations (Unix files, IOS, JUNOS), later XML-RPC

COMBO6 card


P/N :77.10603.542
S/N :2302425-00451
256MB UNB PC2100 CL2
WARRANTY VOID IF LABEL REMOVED
Apacer
XILINX
XC2V3000
BF957AMT0237
D1233173A
TAIWAN
REV
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c 2002 CESNET
Designed by CAMEA
COMBO6 1.1

COMBO6 architecture

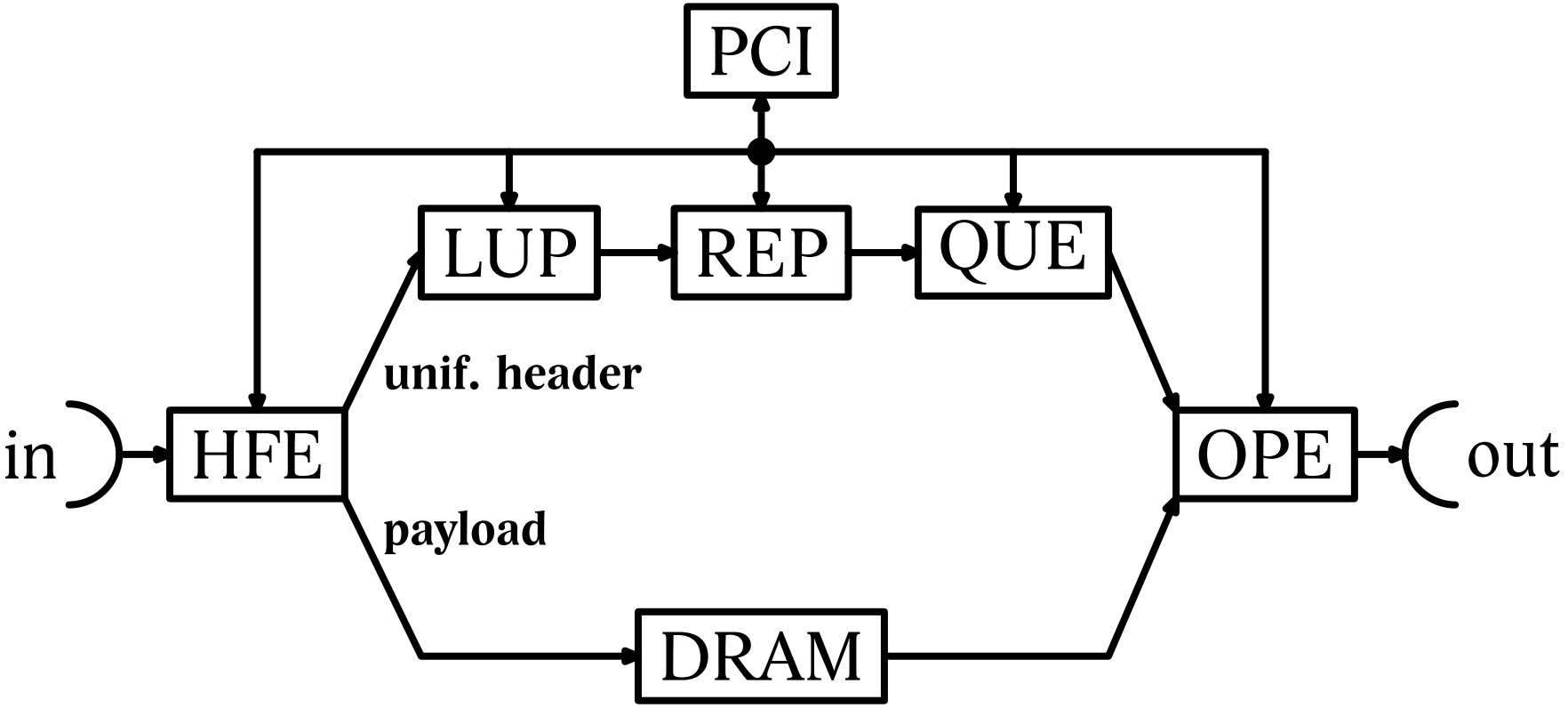
No processor, combination of programmable hardware and standard integrated circuits

- Xilinx FPGA (Virtex II 3000–8000), CPLD
- CAM, RAM, DRAM, PCI interface, power supply
- Exchangeable interface cards
- Test/extension connector

Firmware

- Modular design
- VHDL – standard development approach with simulation, requires expensive development environment
- Concept of “nanoprocessors” makes simple reprogramming possible
- Nanoprocessors are also simulated
- Hardware/software co-design: algorithms are first implemented in software and their time-critical parts are gradually moved to hardware
- Support from formal verification group

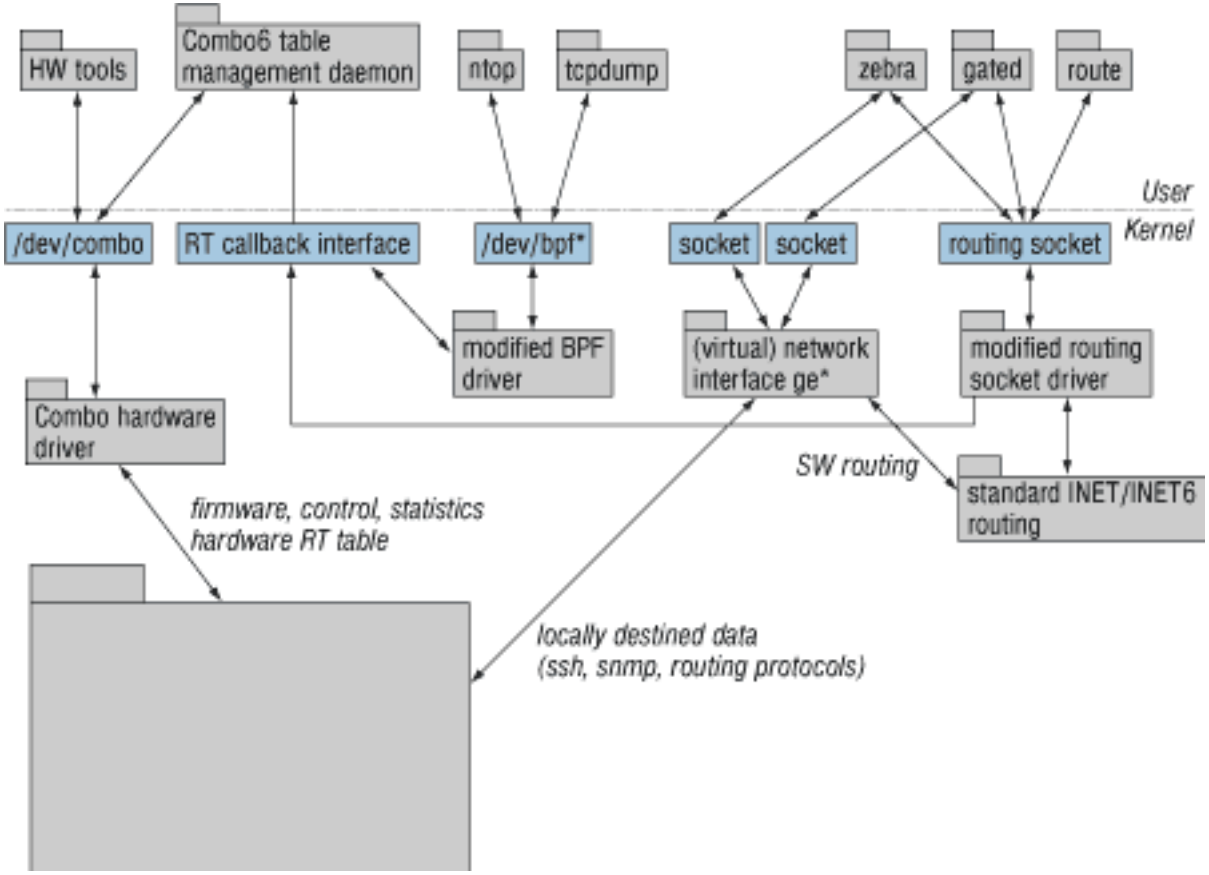
Packet processing



System software

- Development for NetBSD and Linux
- COMBO6 driver presents the card to the system as a standard 4-port Ethernet card
- *combo6* daemon with hooks in the OS: necessary changes are propagated into the COMBO6 card
- Configuration can be done mostly by standard Unix utilities (*ifconfig*, *route*, . . .)
- Standard routing daemons can be used
- *tcpdump* support

System software (cont.)



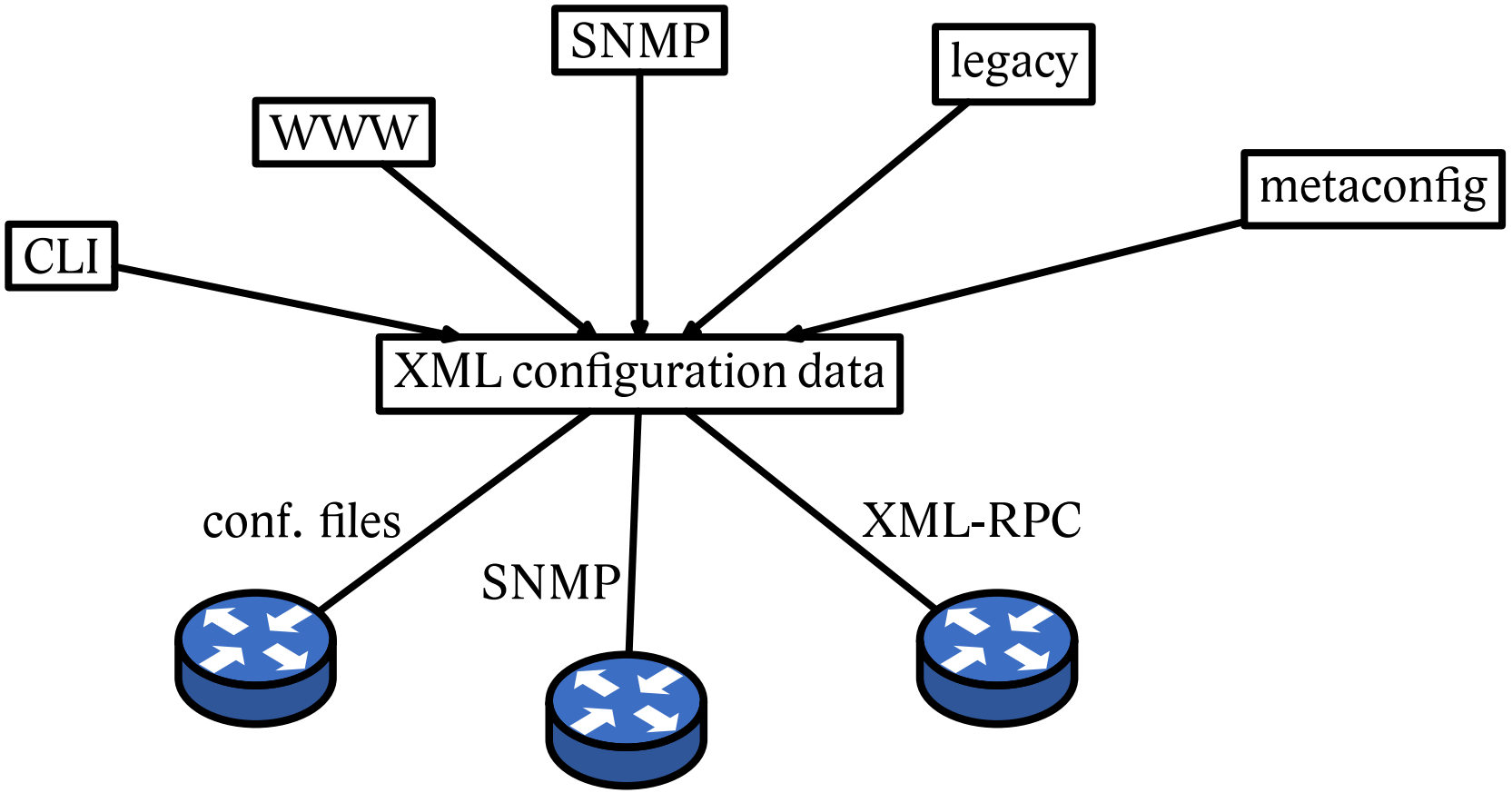
Current status

- 4 COMBO6 cards manufactured and tested (~€3.500)
- Interface card 4×GE (copper)
- Low-level driver for NetBSD and Linux
- Development tools – *comboctl*, TCL scriptable
- Intensive work on the firmware and software

Netopeer configuration system

- Powerful platform-independent environment for configuring large heterogeneous networks
- Central configuration repository with version control
- Internal data format based on XML
- *Netconf* group in IETF: communication protocol (XML-RPC), not data contents
- Netopeer development concentrates on configuration data and their transformations

Netopeer architecture



Current status

- Preliminary XML schema (DTD): interface configuration (incl. VLANs and tunnels), packet and route filtering, static routes, RIP and RIPng.
- Front-ends: Cisco IOS, JUNOS, web
- Back-ends (XSLT): Cisco IOS, Linux/NetBSD

Further information

- Project site – *http://www.liberouter.org*
- All project files publicly available from CVS
- Mailing lists
- Project team has already 45 members, but contributors are still very welcome!