Recovering Device Drivers,
or, Cleaning Up Nooks

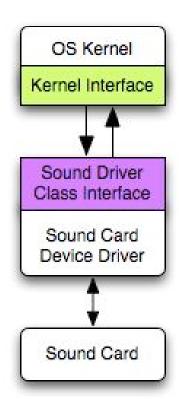Mike Swift, Annamali Muthu, Brian Bershad, Hank Levy

Problem

- **Applications still fail with Nooks**
  - They get errors back from system calls
  - Their driver state gets lost
    - E.g. file handles + history of ioctls configuring the device
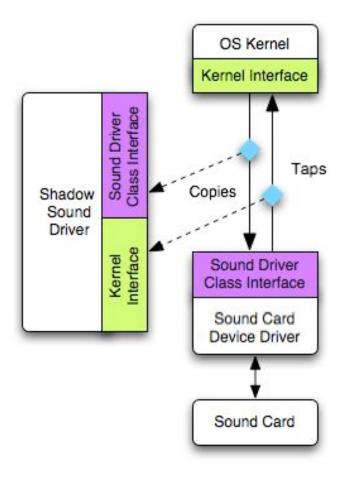
Solution

- Shadow drivers
  - New kernel agent for recovering device drivers
  - Passively observes driver-kernel communication during normal operation
  - After failure,
    - Actively impersonate driver to applications (prevent errors)
    - Transparently restart driver (prevent errors)
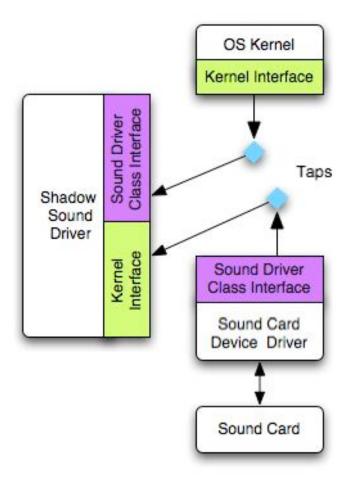   - Transfer state back to driver (prevent lost state)

Native Linux

Passive Architecture

Active Architecture

Evaluation - Drivers

Sound	**emu10k1**, es1371, sb16, cs4232, i810_audio
Network	**e1000**, pcnet32, 3c59x, epic100, e100
IDE	**ide-disk**, ide-cd

Evaluation - Reliability
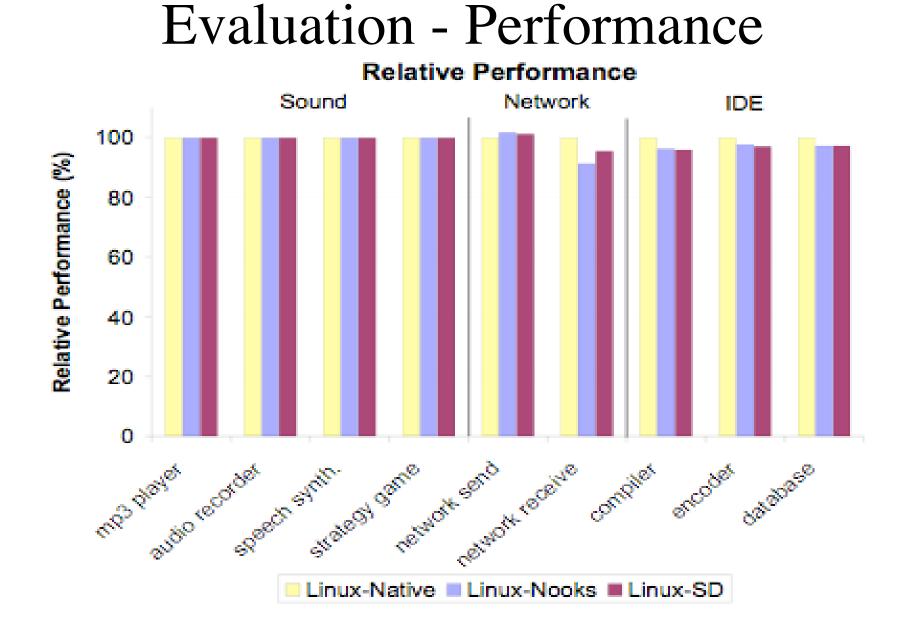
	Native	Nooks	Shadows
Mp3 player	APP. CRASH		
Audio Recorder	SYS. CRASH		
Specth Synth.	SYS. CRASH		
Game	SYS. CRASH		
Remote copy	SYS. CRASH		
Remote window	SYS. CRASH		
Packet Sniffer	SYS. CRASH		
Compiler	SYS. CRASH		
Encoder	SYS. CRASH		
Dataase	SYS. CRASH		

Evaluation - Reliability

	Native	Nooks	Shadows
Mp3 player	APP. CRASH	APP. BREAK	
Audio Recorder	SYS. CRASH	APP. BREAK	
Speech Synth.	SYS. CRASH	**WORKS**	
Game	SYS. CRASH	APP. CRASH	
Remote copy	SYS. CRASH	**WORKS**	
Remote window	SYS. CRASH	**WORKS**	
Packet Sniffer	SYS. CRASH	APP. BREAK	
Compiler	SYS. CRASH	SYS. CRASH	
Encoder	SYS. CRASH	SYS. CRASH	
Dataase	SYS. CRASH	SYS. CRASH	

Evaluation - Reliability

	Native	Nooks	Shadows
Mp3 player	APP. CRASH	APP. BREAK	**WORKS**
Audio Recorder	SYS. CRASH	APP. BREAK	**WORKS**
Speech Synth.	SYS. CRASH	**WORKS**	**WORKS**
Game	SYS. CRASH	APP. CRASH	**WORKS**
Remote copy	SYS. CRASH	**WORKS**	**WORKS**
Remote window	SYS. CRASH	**WORKS**	**WORKS**
Packet Sniffer	SYS. CRASH	APP. BREAK	**WORKS**
Compiler	SYS. CRASH	SYS. CRASH	**WORKS**
Encoder	SYS. CRASH	SYS. CRASH	**WORKS**
Dataase	SYS. CRASH	SYS. CRASH	**WORKS**

Evaluation - Performance

Evaluation - Code Size

Driver Class	# of drivers in class	Code size for all drivers	Example Driver Size	Shadow Driver Size
Sound	48	111,600	8,080 (emu10k1)	666
Network	190	264,500	9,842 (e1000)	198
IDE	8	29,000	5,358 (ide-disk)	321

- Nooks: 23,000
- Shadow manager: 600
- Common code: 750

Conclusions

- Applications need more than fault isolation to survive driver crashes

- Shadow drivers are a low-overhead, efficient mechanism to conceal driver failures from applications