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Agile Application-Aware Adaptation for Mobility

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Outline

- Introduction
- Design Rationale
- Application-Aware Adaptation
- Design and Implementation
- Example Applications
- Evaluation
- Conclusion

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Introduction

- Adaptation is the key to mobility.
 - Offer acceptable service in spite of the many problems that plague its existence.
- Odyssey
 - A set of extensions to the NetBSD to support adaptation.

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Design Rationale

- Motivation
- Fidelity
 - The degree to which data presented at a client matches the reference copy at the server.
- Concurrency
 - Needs to be centralized monitoring and coordinated resource management on a mobile client.



Design Rationale

- Agility
 - The speed and accuracy with which it detects and responds to changes in resource availability.
 - Changed demand
- Minimalism



Application-Aware Adaptation

- Model of Adaptation
 - Application-aware adaptation.
 - Between system and individual applications.
 - System monitors resource levels, notifies applications of relevant changes.

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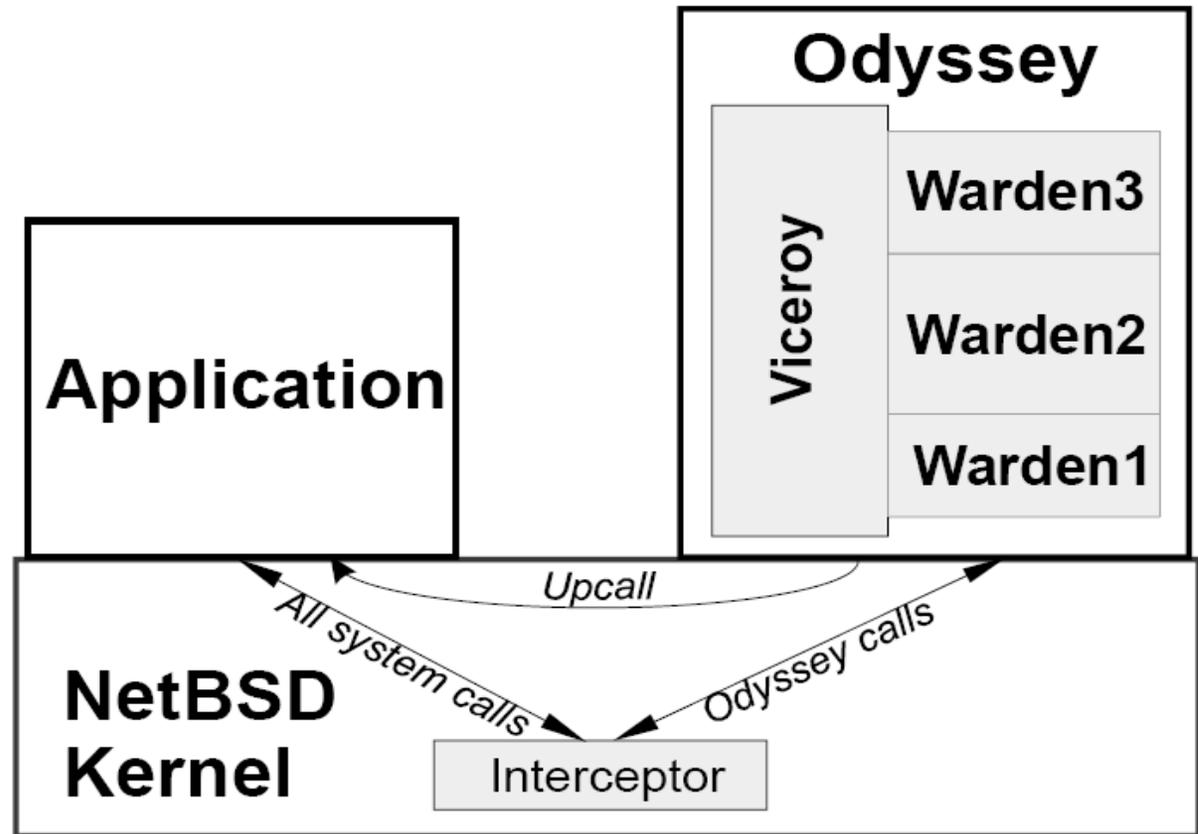
Application-Aware Adaptation

- Realizing the model
 - In such an architecture, system code would treat data generically.
 - But it is impossible to optimize without some system-level knowledge of type.
 - *Wardens*
 - Encapsulates the system-level support at a client necessary to effectively manage a data type.
 - Viceroy
 - Responsible for centralized resource management.

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Design and implementation





Design and implementation

```
request(in path, in resource-descriptor, out request-id)  
cancel(in request-id)
```

(a) Resource Negotiation Operations

```
resource-id  
lower bound  
upper bound  
name of upcall handler
```

(b) Resource Descriptor Fields



Design and implementation

```
handler(in request-id, in resource-id, in resource-level)
```

(d) Upcall Handler

```
tsop(in path, in opcode, in insize, in inbuf,  
inout outsize, out outbuf)
```

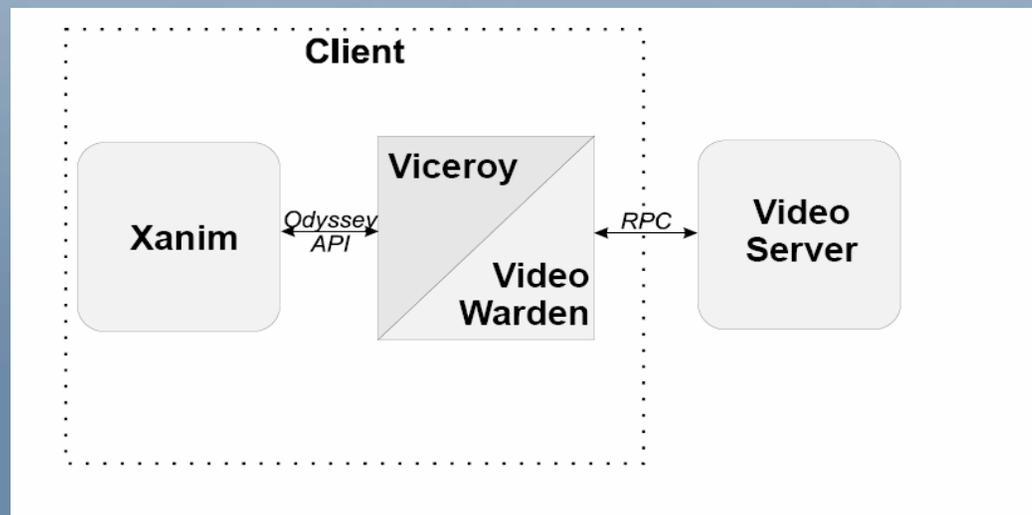
(e) Type-Specific Operations

```
tsop(in path, in opcode, in insize, in inbuf,  
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(e) Type-Specific Operations

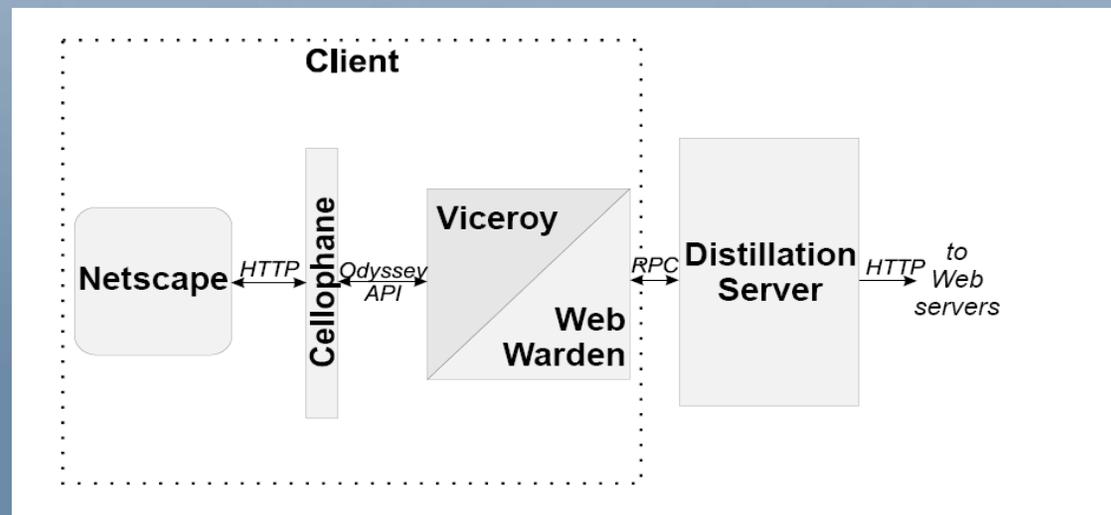
Example Applications

- Video Player
- Each movie is stored in multiple tracks at the server.
- tsops
 - Read a movie's meta-data
 - Get a particular frame from a specified track.



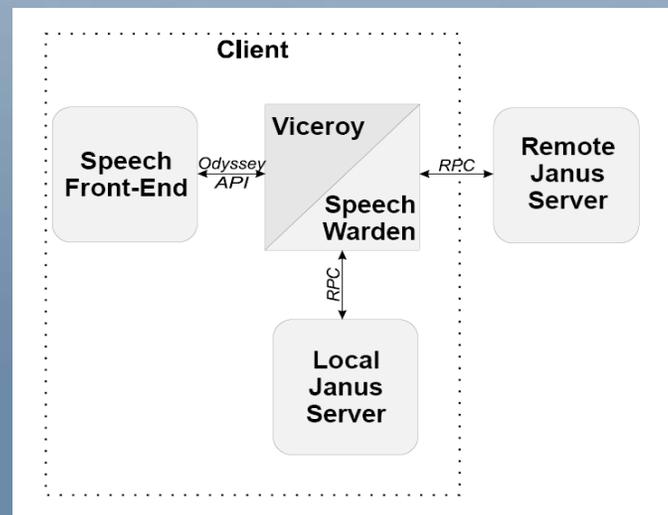
Example Applications

- Web Browser
- Cellophane
 - makes use of the Odyssey API
 - selects fidelity levels.
- Distillation server
 - Fetches requested objects from the appropriate server.
 - Distills objects to the requested fidelity level.



Example Applications

- Speech Recognizer
- Warden decides whether it is faster to perform on the local slower CPU.
- Or to ship the larger raw utterance to the server.





Evaluation



(a) Step-Up



(b) Step-Down



(c) Impulse-Up



(d) Impulse-Down



Evaluation

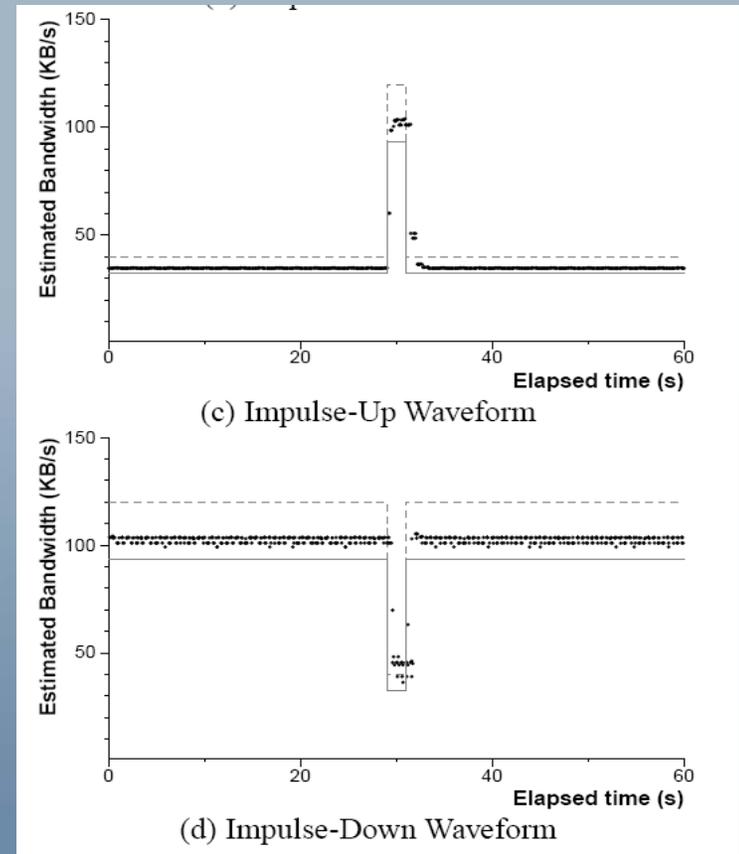
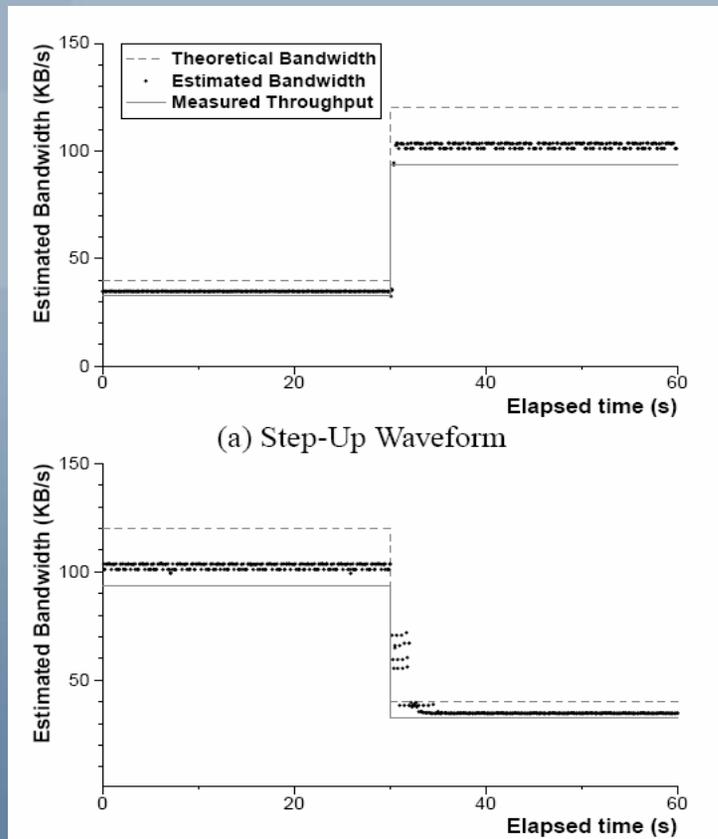
- How Agile is Odyssey?
 - $\text{new} = \alpha(\text{measured}) + (1 - \alpha)(\text{old})$

$$B = \frac{D}{T_{win} - (T_{rtt} / 2)}$$

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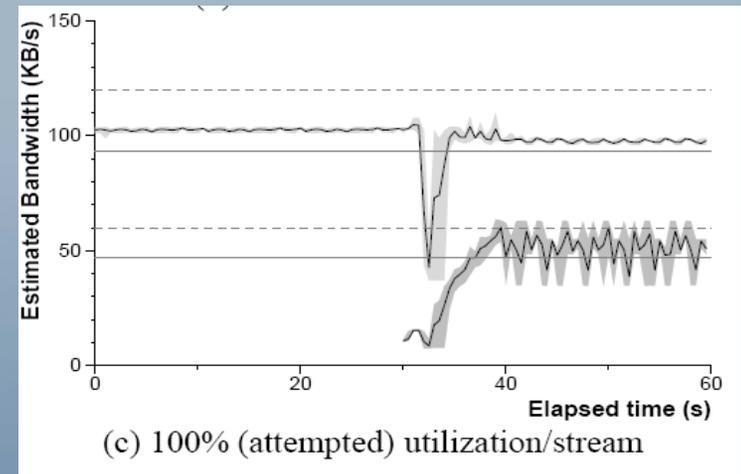
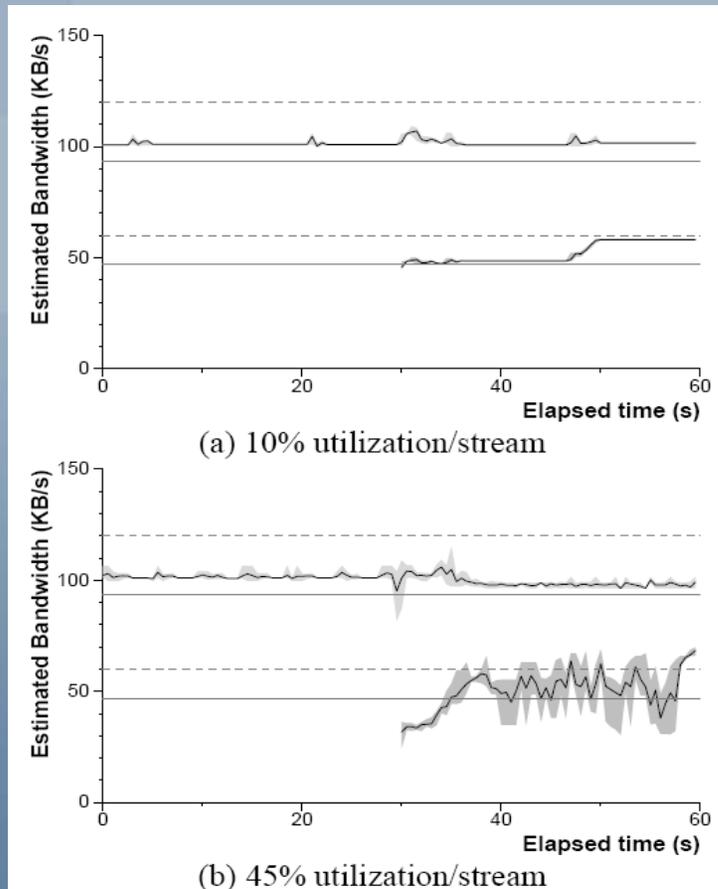


Evaluation





Evaluation





Evaluation

- How Beneficial is Adaptation?
- Video player
 - JPEG(99) 1.0
 - JPEG(50) 0.5
 - Black-and-white 0.01

Waveform	B/W		JPEG(50)		JPEG(99)		Odyssey	
	Fidelity = 0.01	Drops	Fidelity = 0.5	Drops	Fidelity = 1.0	Drops	Fidelity	
Step-Up	0	(0.0)	3	(1.8)	169	(0.8)	7	(2.2) 0.73 (0.01)
Step-Down	0	(0.0)	5	(11.2)	169	(2.4)	25	(8.9) 0.76 (0.01)
Impulse-Up	0	(0.0)	3	(0.7)	325	(4.3)	23	(7.4) 0.50 (0.01)
Impulse-Down	0	(0.0)	0	(0.0)	12	(5.7)	14	(6.5) 0.98 (0.01)

Evaluation

- Web Browser

Waveform	JPEG(5)		JPEG(25)		JPEG(50)		Full Quality		Odyssey	
	Fidelity = 0.05	Time (s)	Fidelity = 0.25	Time (s)	Fidelity = 0.5	Time (s)	Fidelity = 1.0	Time (s)	Fidelity	
Ethernet	—	—	—	—	—	—	0.20 (0.00)	—	—	
Step-Up	0.25 (0.01)	0.30 (0.01)	0.29 (0.01)	0.46 (0.01)	0.35 (0.05)	0.78 (0.08)				
Step-Down	0.25 (0.01)	0.30 (0.01)	0.29 (0.01)	0.46 (0.00)	0.35 (0.03)	0.77 (0.04)				
Impulse-Up	0.27 (0.01)	0.33 (0.01)	0.34 (0.00)	0.71 (0.00)	0.42 (0.06)	0.63 (0.08)				
Impulse-Down	0.24 (0.01)	0.27 (0.02)	0.29 (0.01)	0.34 (0.01)	0.36 (0.02)	0.99 (0.01)				



Evaluation

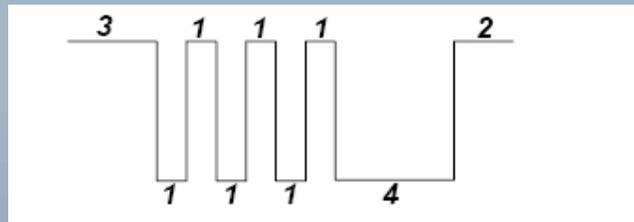
- Speech Recognizer

Waveform	Recognition Time (sec.)					
	Always Hybrid		Always Remote		Odyssey	
Step-Up	0.80	(0.00)	0.91	(0.00)	0.80	(0.00)
Step-Down	0.80	(0.00)	0.90	(0.00)	0.80	(0.00)
Impulse-Up	0.85	(0.00)	1.11	(0.00)	0.85	(0.00)
Impulse-Down	0.76	(0.00)	0.77	(0.00)	0.76	(0.01)



Evaluation

- How important is Centralized Resource Management?



	Video		Web		Speech
	Drops	Fidelity	Seconds	Fidelity	Seconds
Odyssey	1018 (48.6)	0.25 (0.00)	0.54 (0.02)	0.47 (0.01)	1.00 (0.01)
<i>Laissez-Faire</i>	2249 (80.2)	0.39 (0.01)	0.95 (0.03)	0.93 (0.01)	1.21 (0.01)
Blind-Optimism	5320 (23.3)	0.80 (0.00)	1.20 (0.00)	1.00 (0.00)	1.26 (0.02)



Conclusion

- Odyssey architecture supports application-aware adaptation
- Confirms the feasibility of realizing this architecture
- Ability to support a wide range of applications

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