ENERGY-AWARE ADAPTATION FOR MOBILE APPLICATIONS

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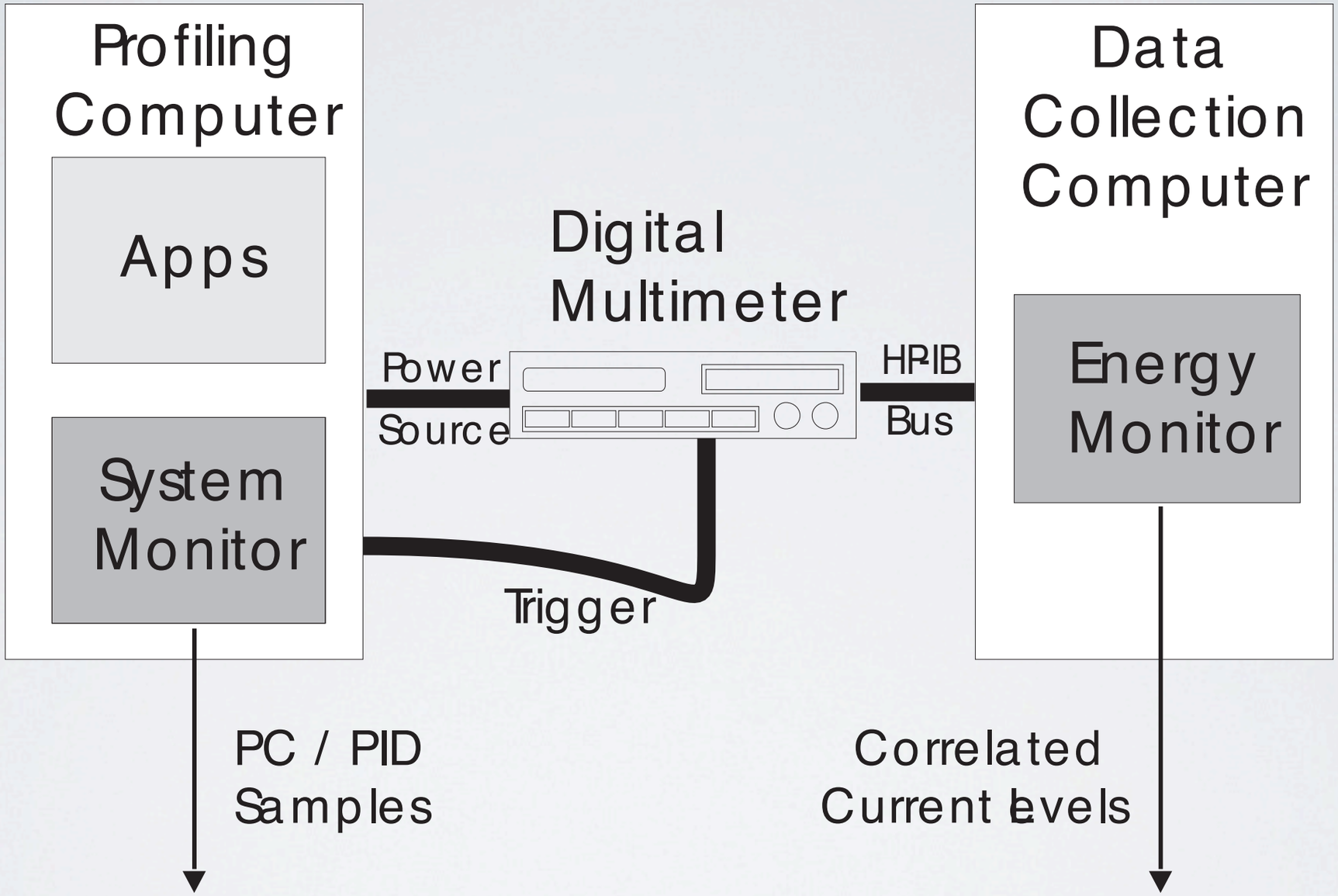
MOTIVATION

- energy is important in mobile-use scenarios
- we all know…
- applications can modify behavior to conserve energy
- dynamically at runtime
- collaboration between OS and applications


Profiling
Computer
Apps
System
Monitor
Digital
Multimeter
Power
Source
HP-IB
Bus
Trigger
Data
Collection
Computer
Energy
Monitor
PC / PID
Samples
Correlated
Current Levels

Process	CPU Time(s)	Total Energy(J)	Average Power(W)
/usr/odyssey/bin/xanim	66.57	643.17	9.66
/usr/X11R6/bin/X	35.72	331.58	9.28
Kernel	50.89	328.71	6.46
Interrupts-WaveLAN	18.62	165.88	8.91
/usr/odyssey/bin/odyssey	12.19	123.40	10.12
Total	183.99	1592.75	8.66

Energy Usage Detail for process /usr/odyssey/bin/odyssey

Procedure	CPU Time(s)	Total Energy(J)	Average Power(W)
_Dispatcher	0.25	2.53	10.11
_IOMGR_CheckDescriptors	0.17	1.74	10.23
_sftp_DataArrived	0.16	1.68	10.48
_rpc2_RecvPacket	0.16	1.67	10.41
_ExaminePacket	0.16	1.66	10.35

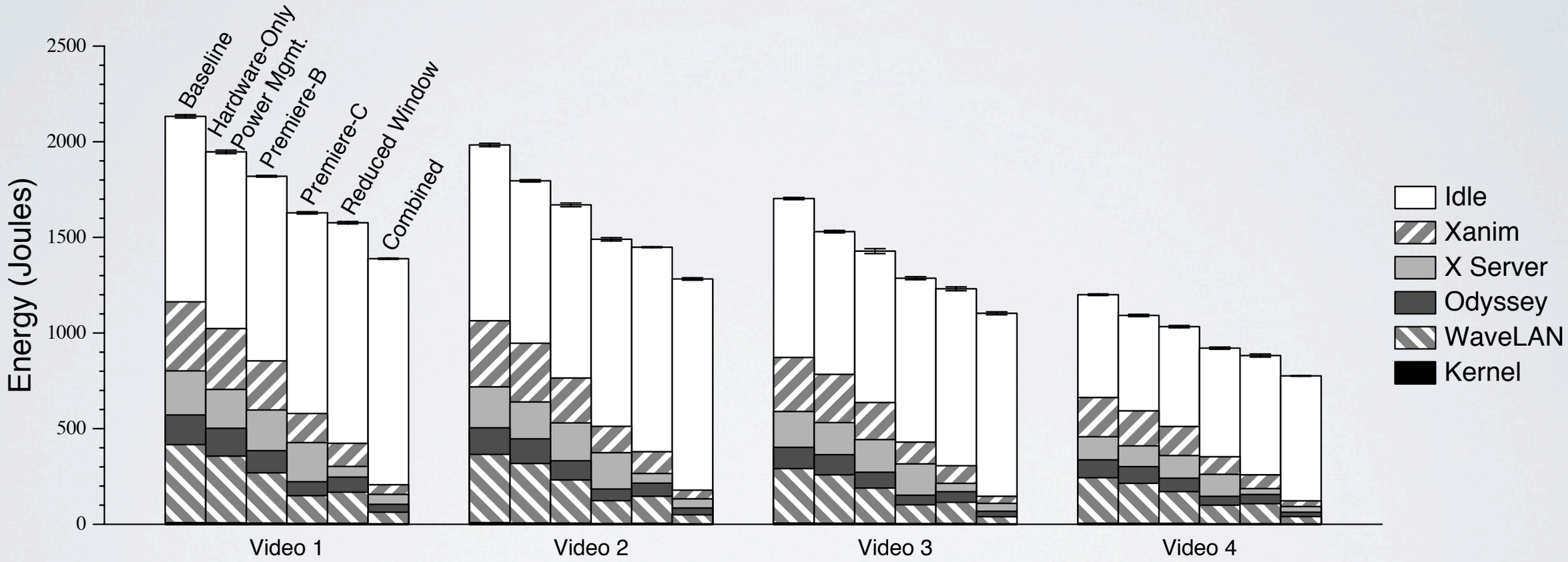
4 CASE STUDIES

1. Video Player
2. Speech Recognizer
3. Map Viewer
4. Web Browser

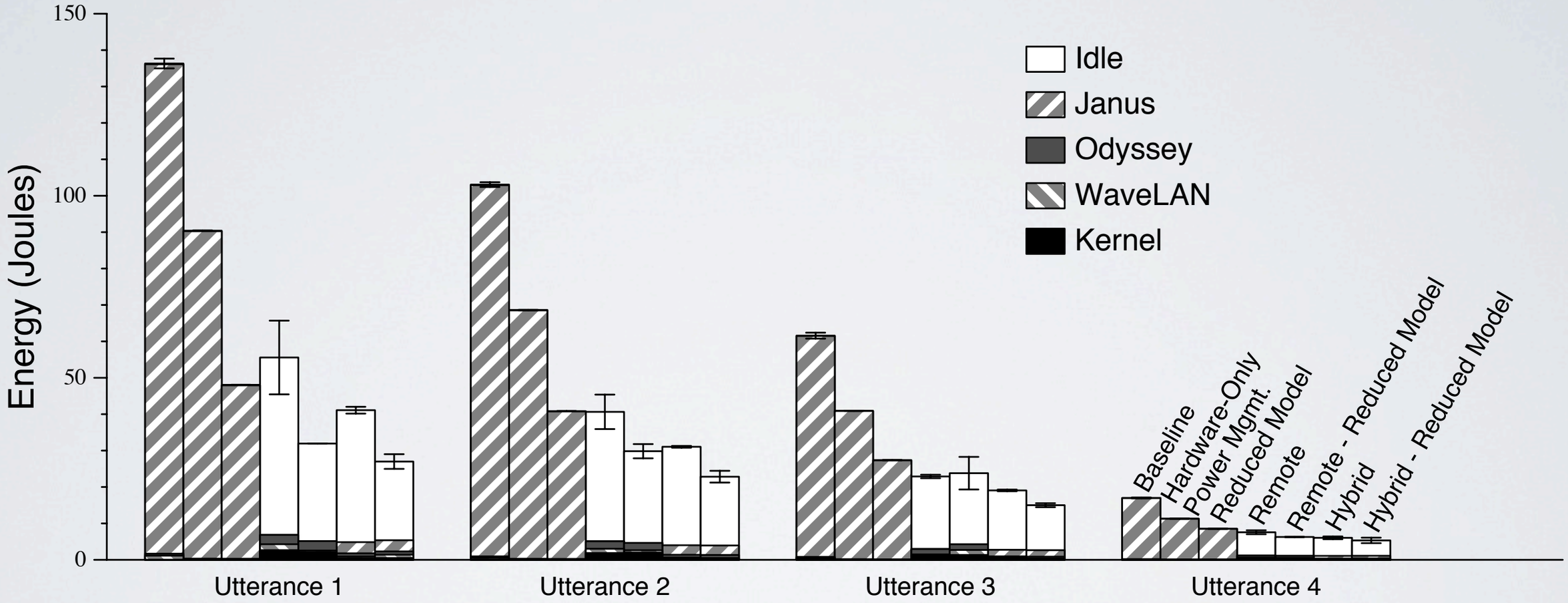
ADAPTIVITY

fidelity = utility?

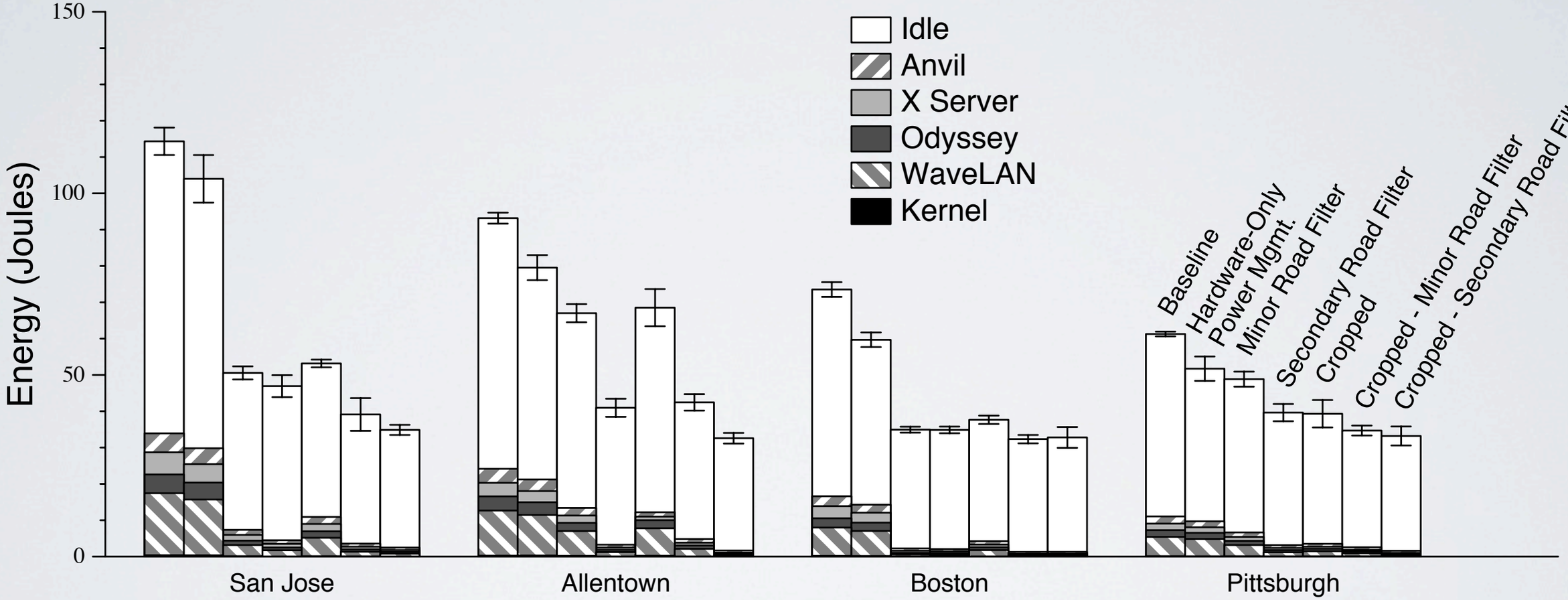
VIDEO PLAYER



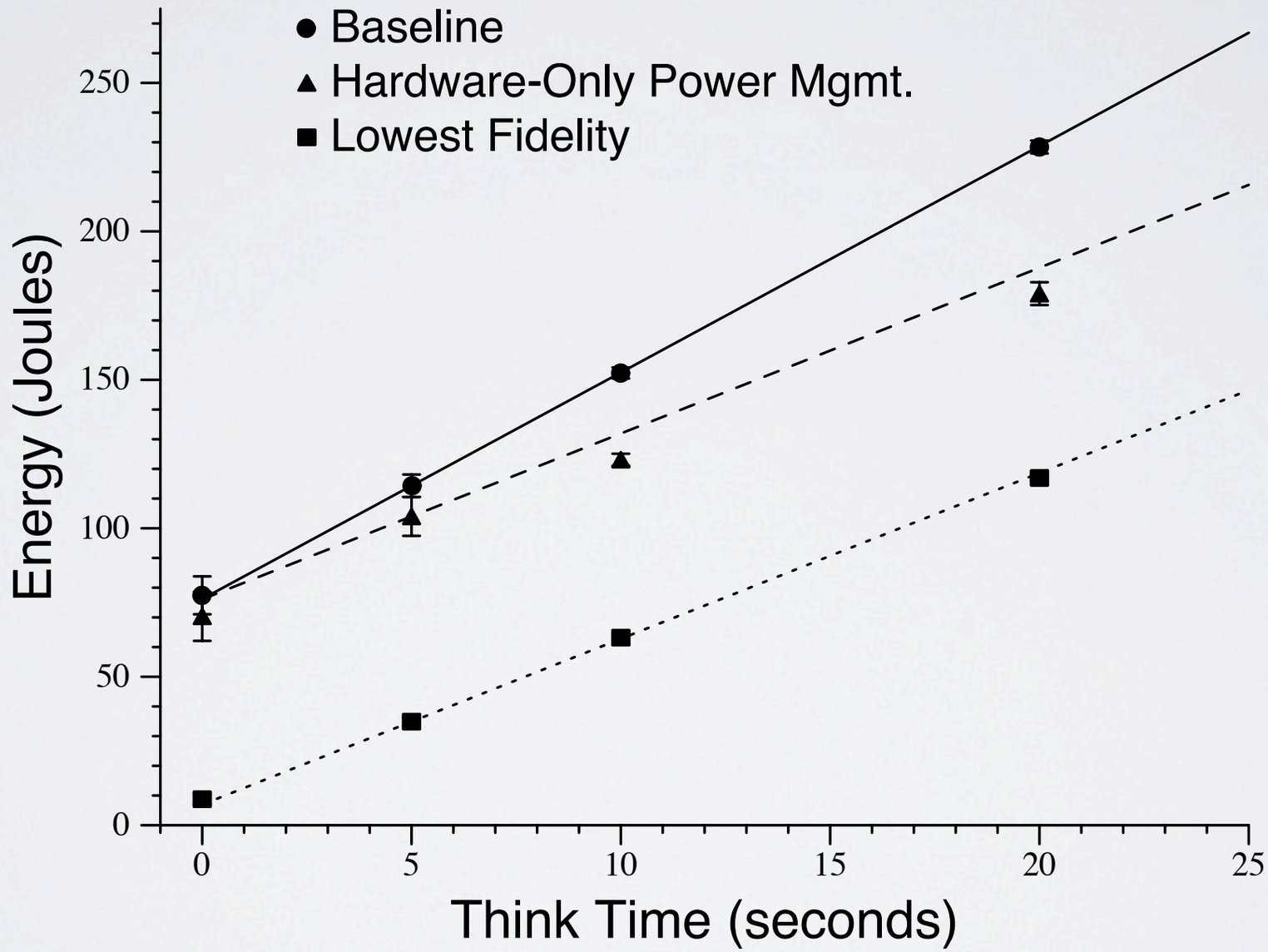
SPEECH RECOGNITION



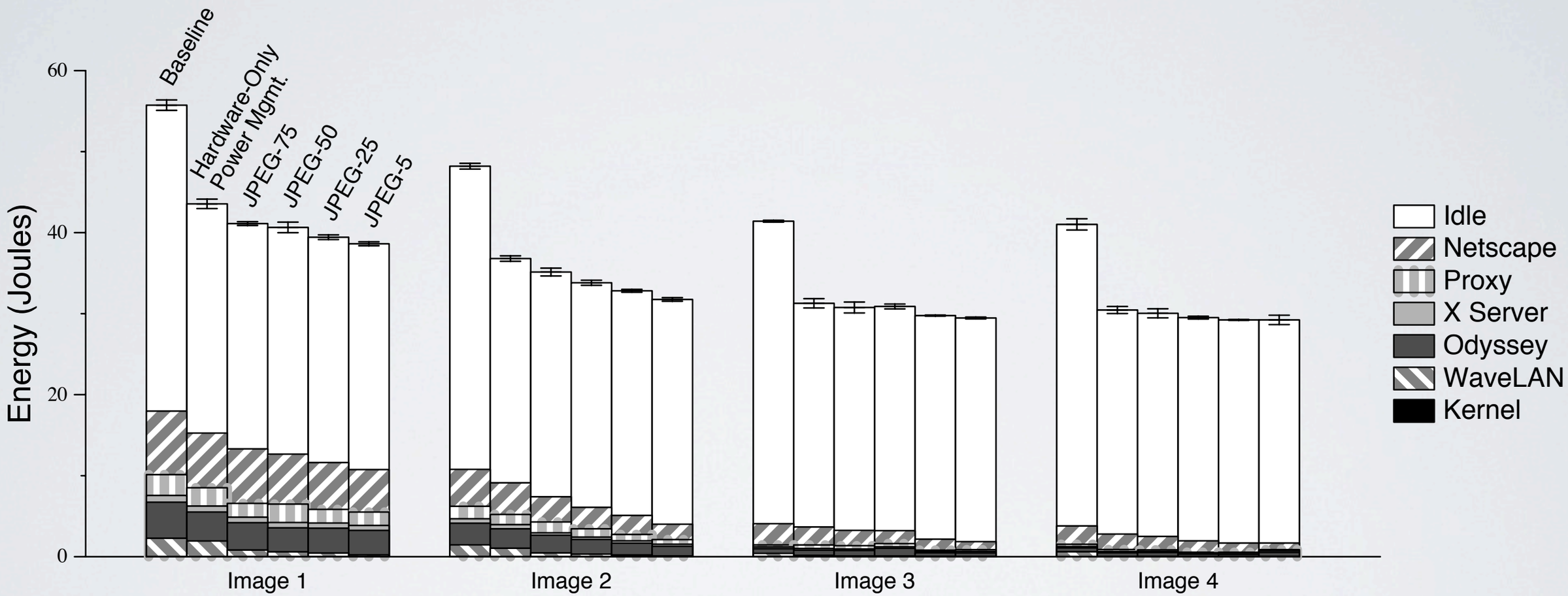
MAP VIEWER


Energy (Joules)
150
100
50
0
Idle
Anvil
X Server
Odyssey
WaveLAN
Kernel
Baseline
Hardware-Only Power Mgmt.
Minor Road Filter
Secondary Road Filter
Cropped
Cropped - Minor Road Filter
Cropped - Secondary Road Filter
San Jose
Allentown
Boston
Pittsburgh

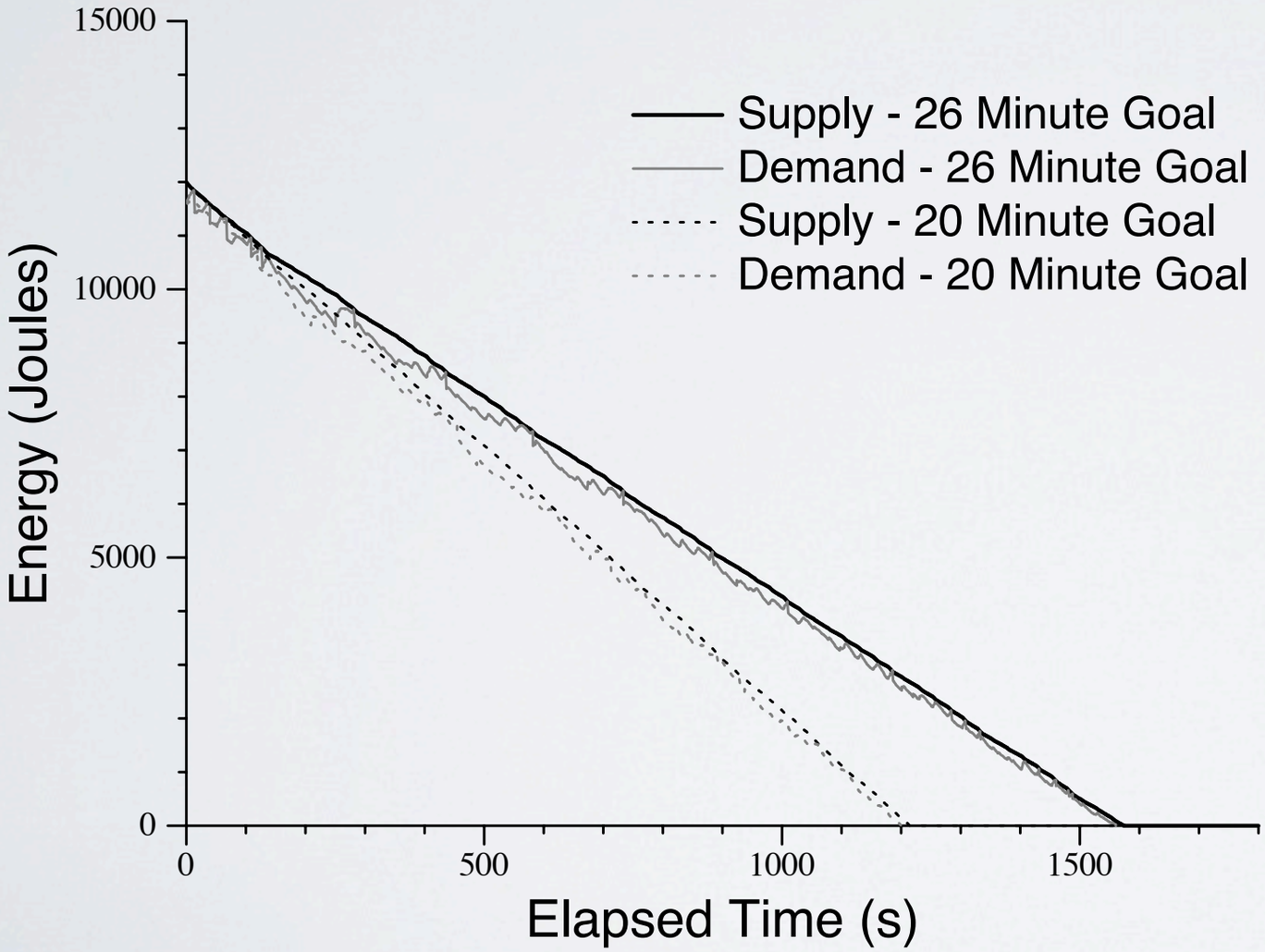
THINK TIME

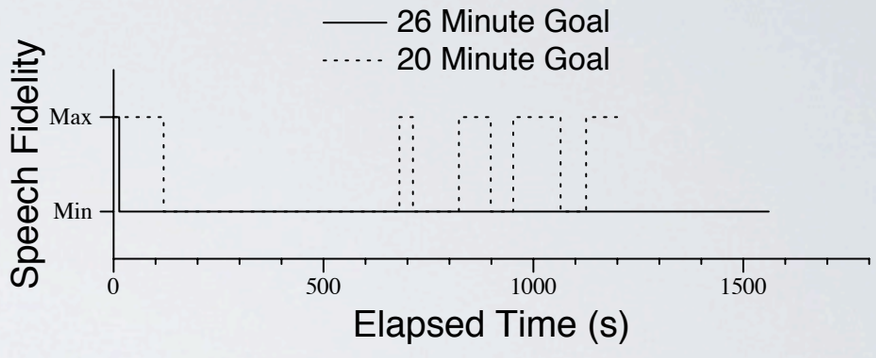

● Baseline
▲ Hardware-Only Power Mgmt.
■ Lowest Fidelity
Energy (Joules)
0
50
100
150
200
250
0
5
10
15
20
25
Think Time (seconds)

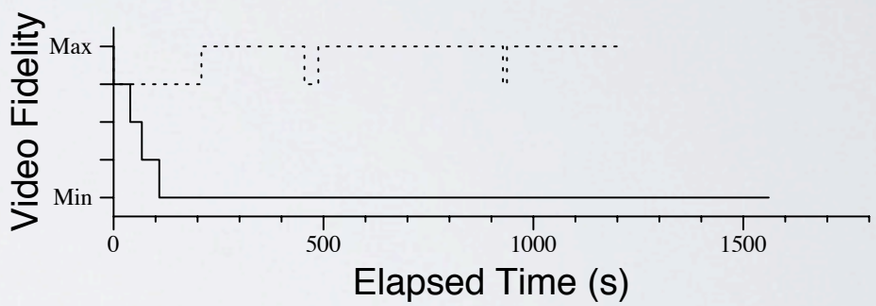
WEB BROWSER

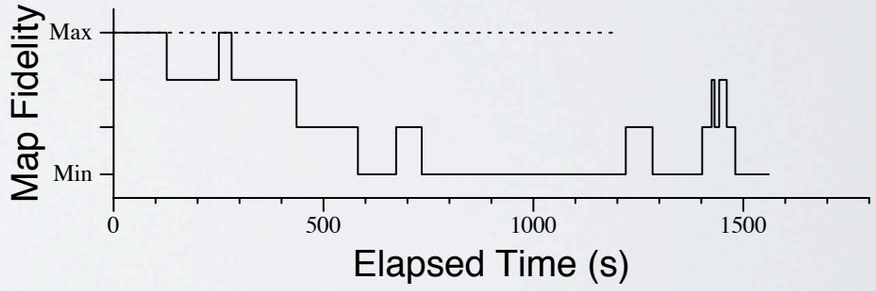

Energy (Joules)
60
40
20
0
Baseline
Hardware-Only Power Mgmt.
JPEG-75
JPEG-50
JPEG-25
JPEG-5
Image 1
Image 2
Image 3
Image 4
Idle
Netscape
Proxy
X Server
Odyssey
WaveLAN
Kernel

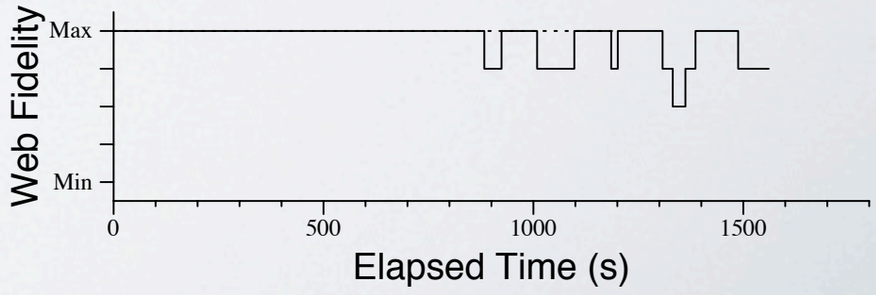
GOAL-DIRECTED ADAPTATION











REAL-TIME

Real-Time	Energy
deadline	battery supply
execution budget	power demand

- energy management is long-term, coarse
- deadlines can be set by the developer
- power demand is generally unknown


MacBook Pro

DISCUSSION

- Good to know, but is it practical?
- A user interface to set energy priorities?
- Savings with no utility impact are a no-brainer, but is the whole adaptivity-concept fundamentally flawed?
- How did they measure their energy usage?