Power-Aware Gaming


9/24 12:00
SONY
ゲーム
UMD®
POWER
HOLD
HOME
VOL
SELECT
START


N81
Music
Now playing
My Song
Music
Podcasts
Playlists
Shuffle all songs
Options
Close
NOKIA


X
Y
A
B
START
SELECT


VAIO

major power consumers:

LCD

CPU

WNIC

e.g., on an iPAQ

LCD (~1W)
CPU (1-3W)
WNIC (1.4W)

"Integrated Power Management for Video Streaming to Mobile Handheld Devices"
Shivajit Mohapatra, Radu Cornea, Nikil Dutt, Alex Nicolau & Nalini Venkatasubramanian
ACM Multimedia 2003

Reducing WNIC's Power Consumption

State	Documented	Measured
WaveLAN - suspended	0W	0W
WaveLAN - receive	1.48W	1.52W
WaveLAN - transmit	3.00W	3.10W

Table 1: Power Requirements of the Lucent WaveLAN PCMCIA Wireless Ethernet card.

Power Management Techniques for Mobile Communication

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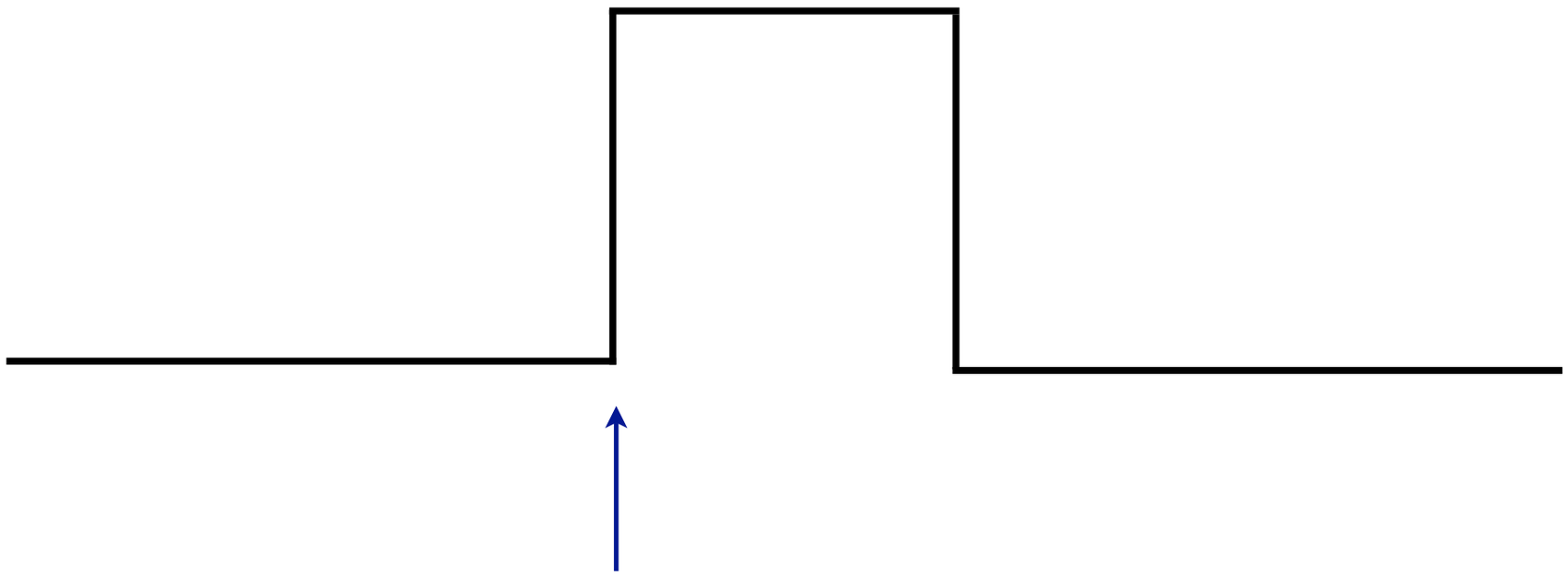
Assume two modes:

active and **suspend**

Idea: suspend WNIC and suppress updates when appropriate

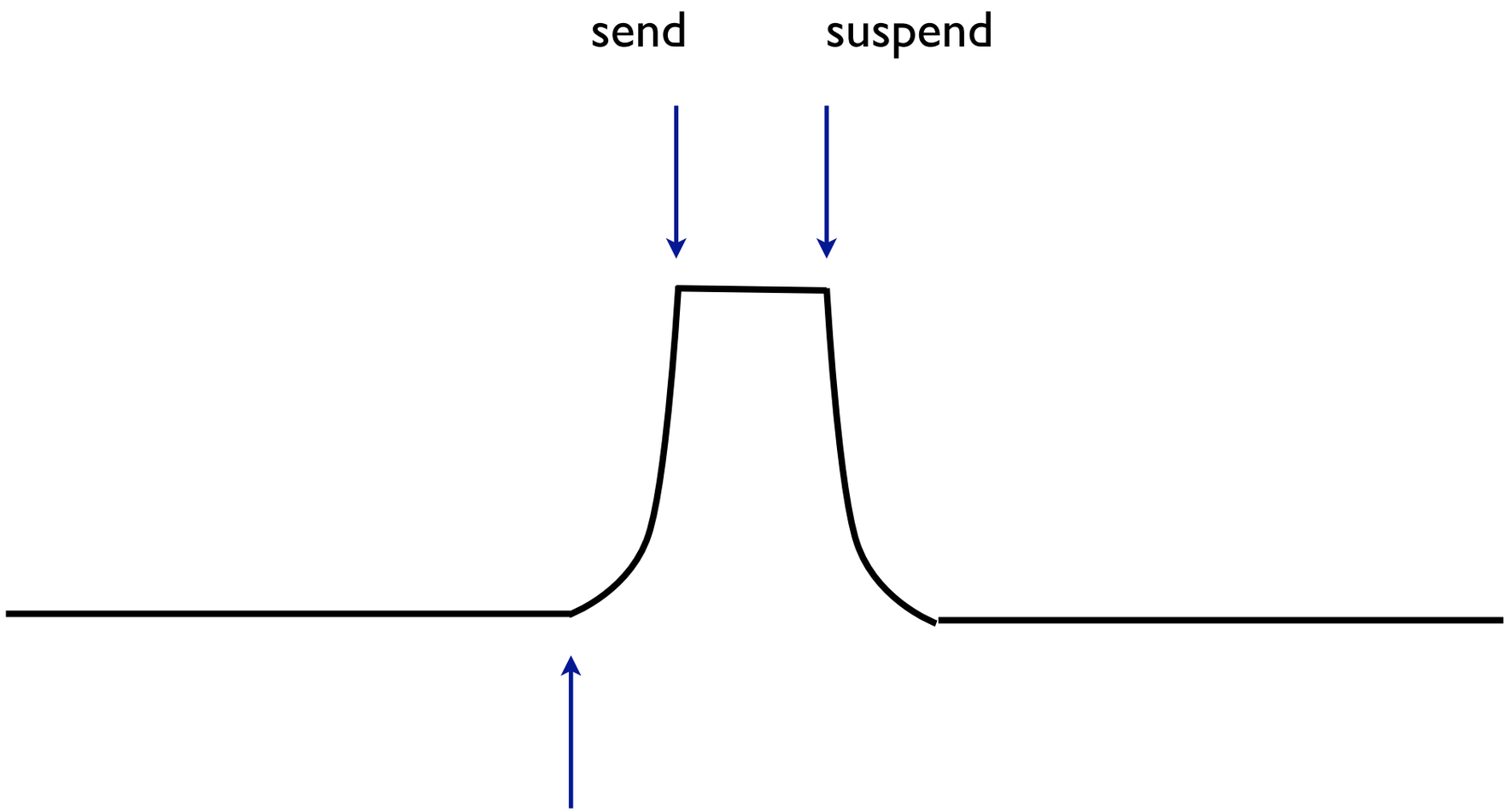
Recall: can suppress updates when diff in position is below threshold



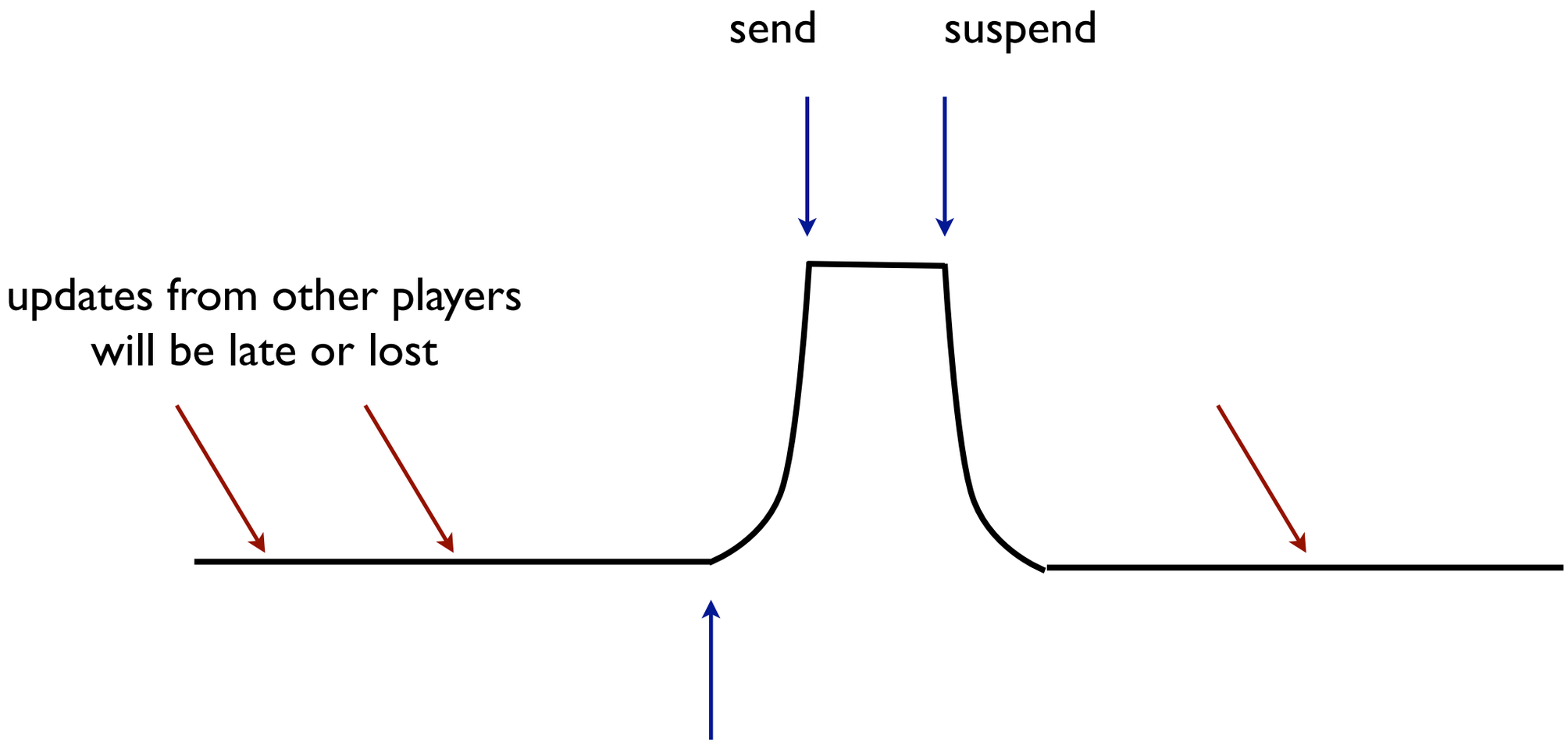
Exceed DR threshold: switch to active, send, suspend again

in practice, mode switching takes time (50-100ms, up to 600ms observed)

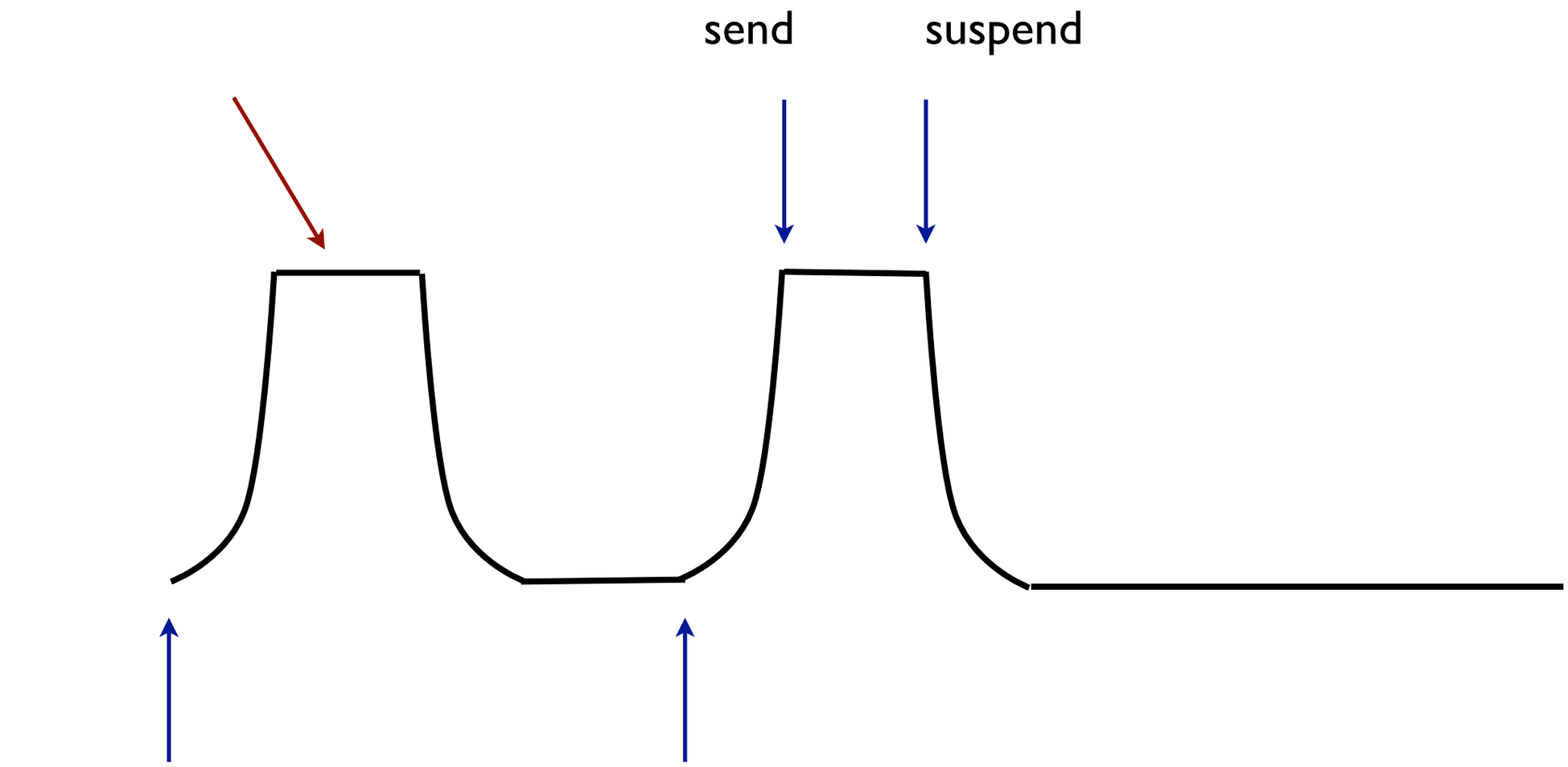
Reduce DR threshold to compensate for switching time



Almost exceed DR threshold:
switch to active


send
suspend
updates from other players
will be late or lost
Almost exceed DR threshold:
switch to active

Consider a client/server model with periodic server updates


send
suspend
Expecting server update
Almost exceed DR threshold:
switch to active

Note: not practical unless server updates rarely or mode switching latency reduces

Problem: Not all updates are predictable even in C/S architecture. More so in P2P architecture.

Cannot predict opponents movement

Reducing WNIC's Power Consumption

remain open!

Reducing CPU's Power Consumption

Game loop:

compute states

render scene

get input

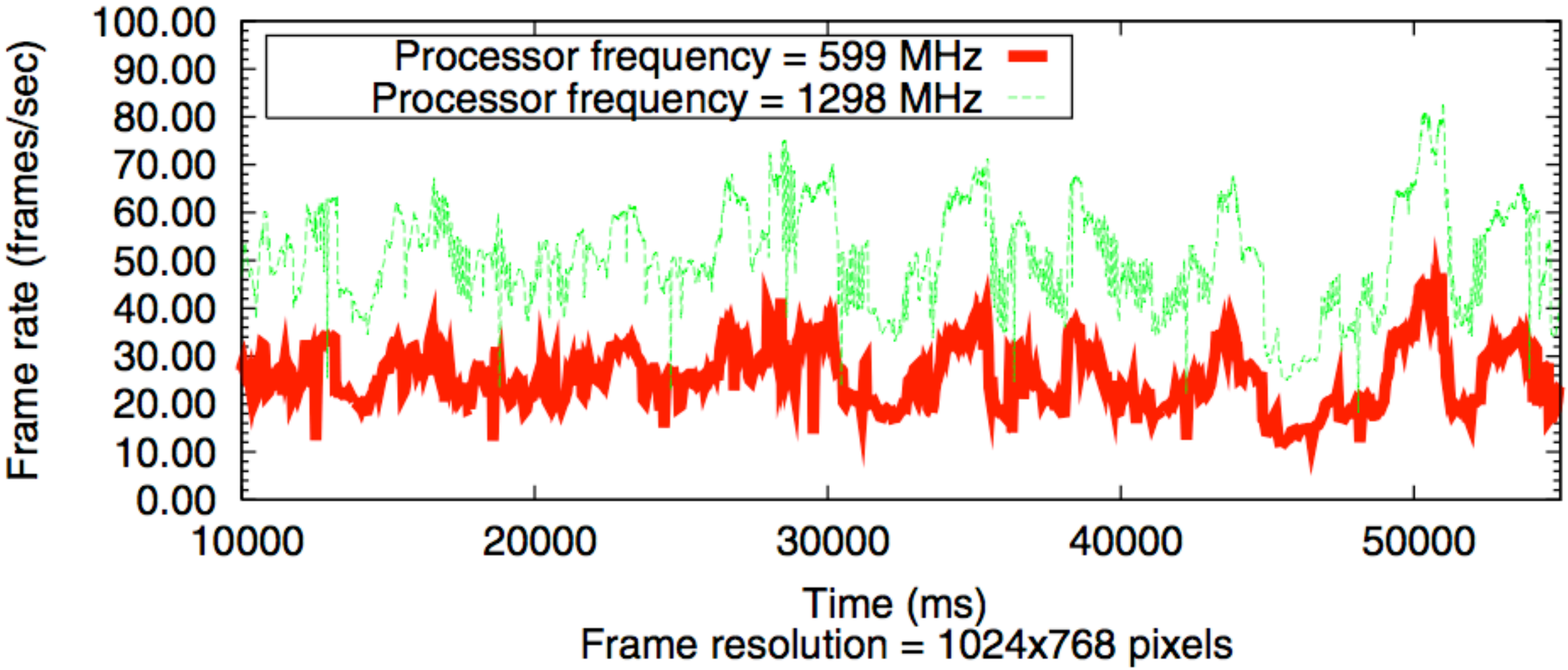
faster CPU : higher frame rate

simpler scene : higher frame rate

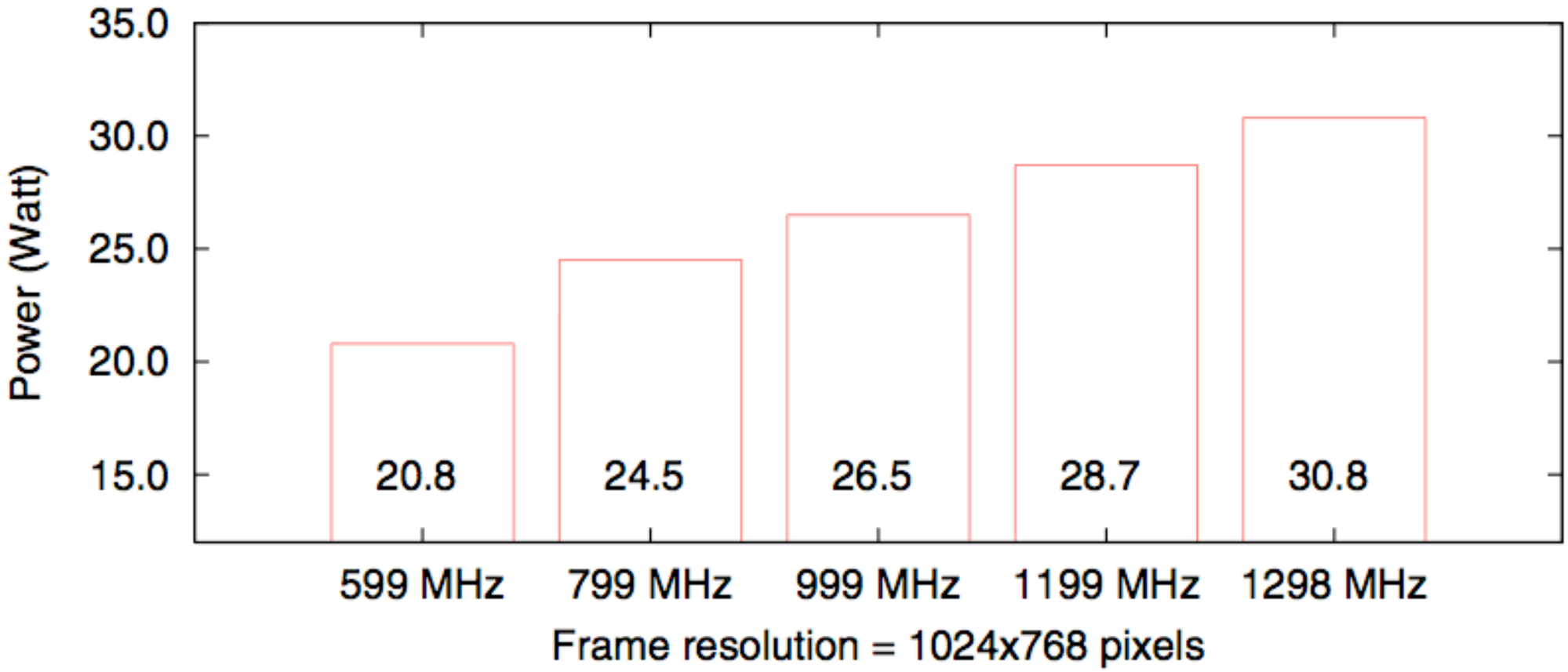
Idea: slow down CPU when scene is simpler (achieving constant frame rate)

“slow down” CPU : dynamic voltage and frequency scaling

$$\text{Power} \propto V^2 f$$



Frame rate of Quake II


35.0
30.0
25.0
20.0
15.0
Power (Watt)
20.8
24.5
26.5
28.7
30.8
599 MHz
799 MHz
999 MHz
1199 MHz
1298 MHz
Frame resolution = 1024x768 pixels

let

c be the estimated cycle requirement to render a scene

f be the min acceptable frame rate

let

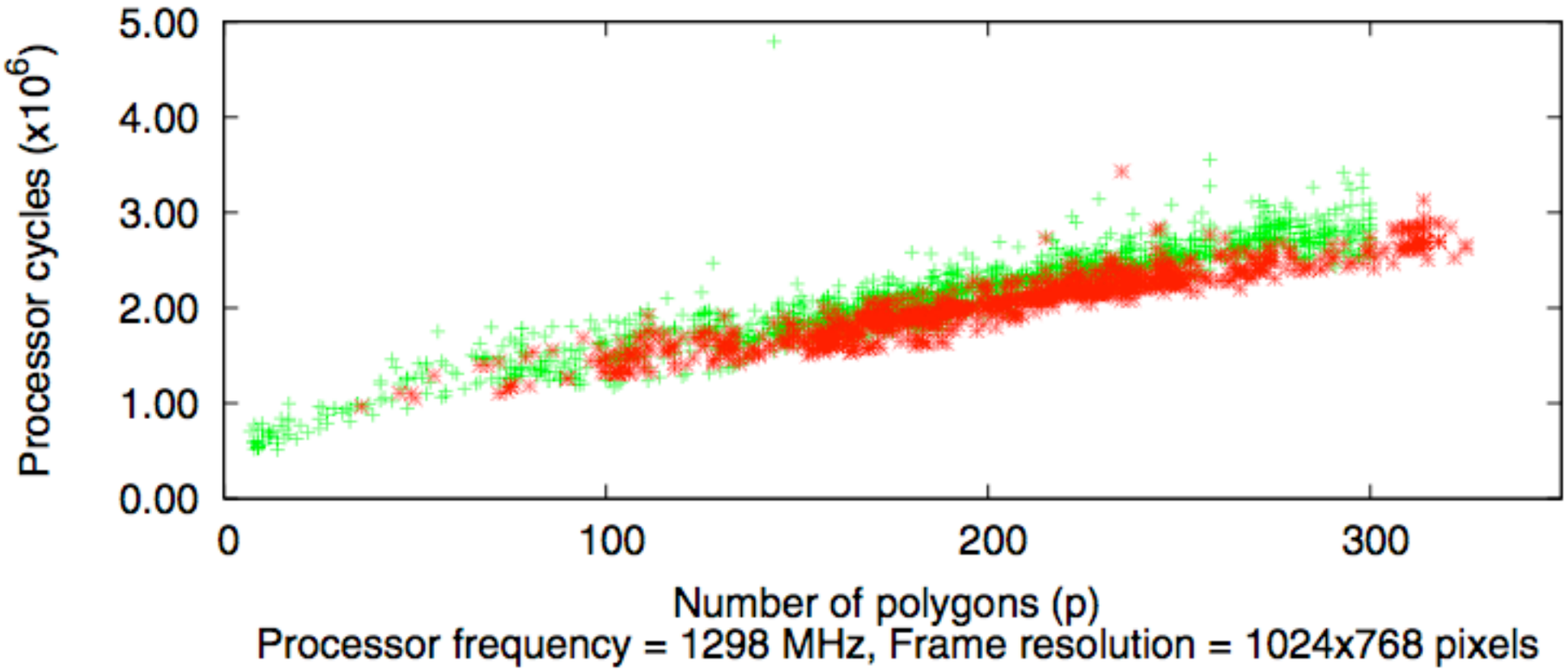
c be the estimated cycle requirement to render a scene

f be the min acceptable frame rate

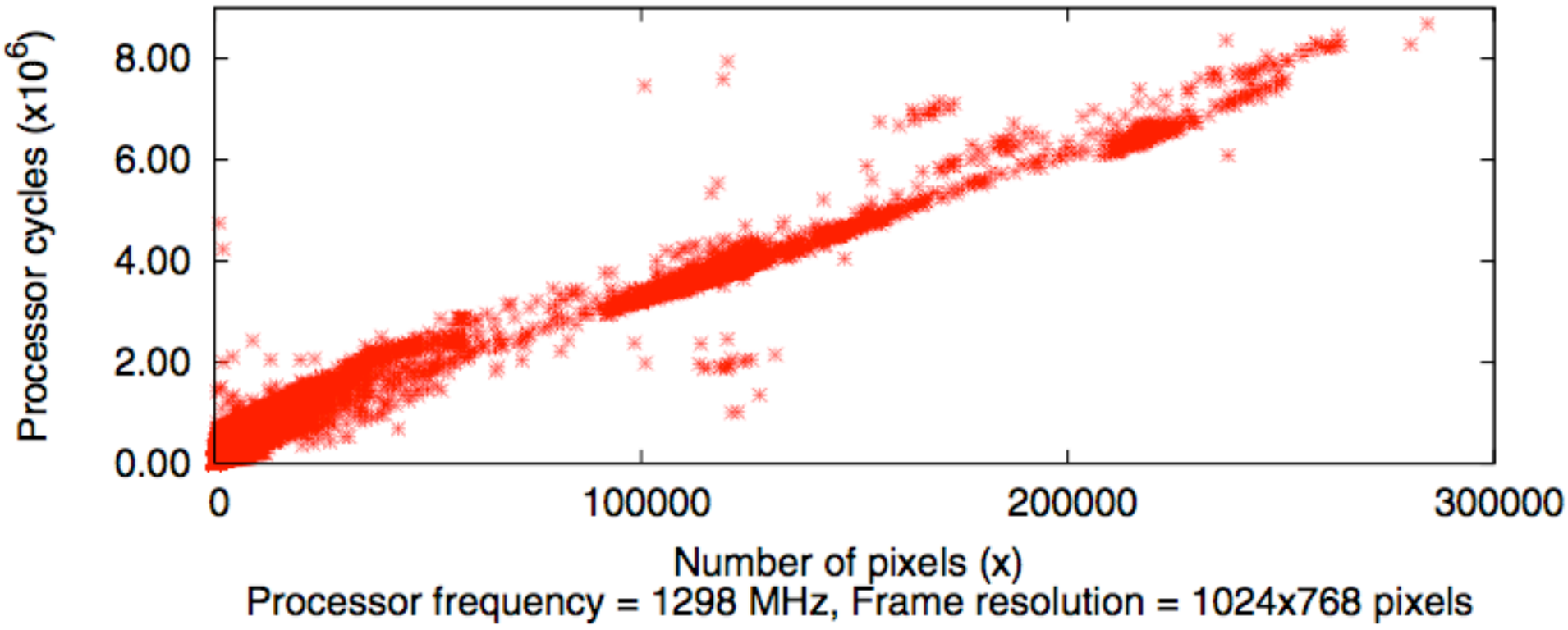
set CPU frequency to **cf** (rounded up to the nearest supported frequency)

How to estimate cycle requirement for a scene?

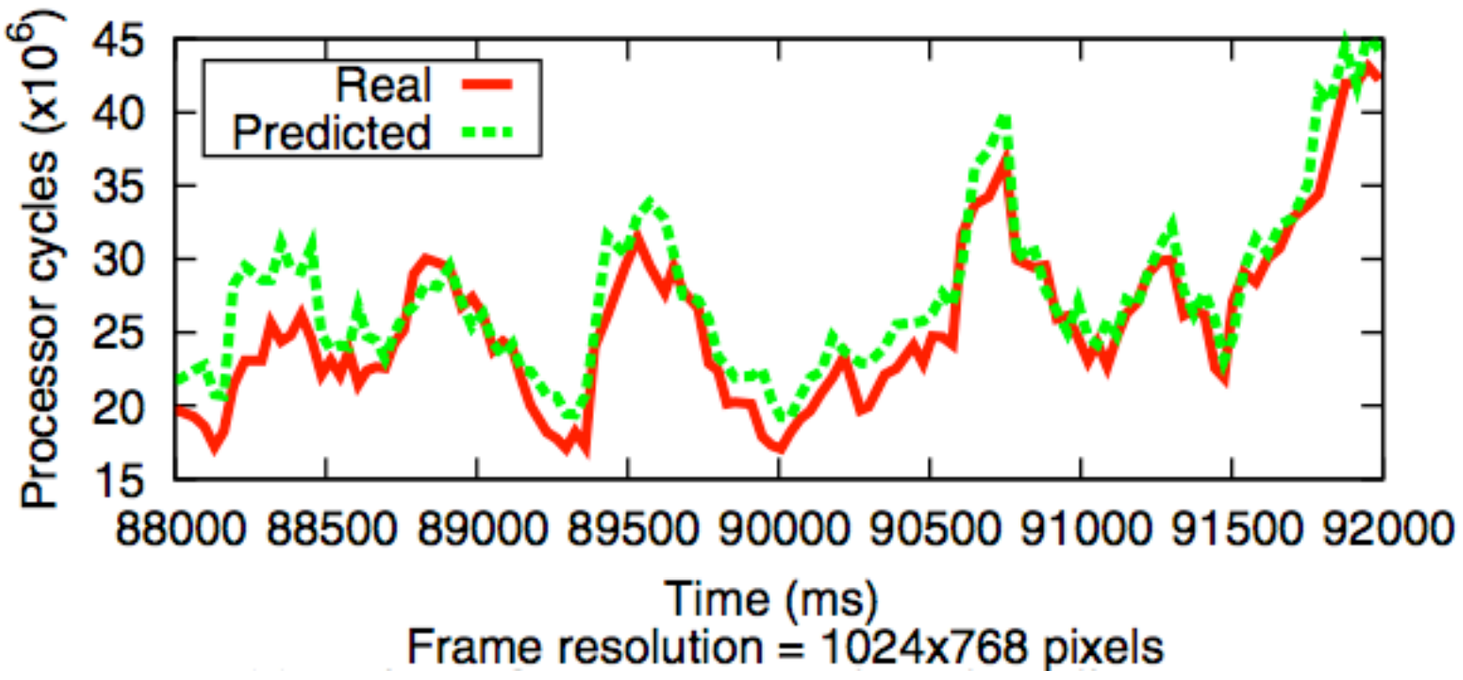
Look at the structure of a scene:
number of polygons,
number of objects ..

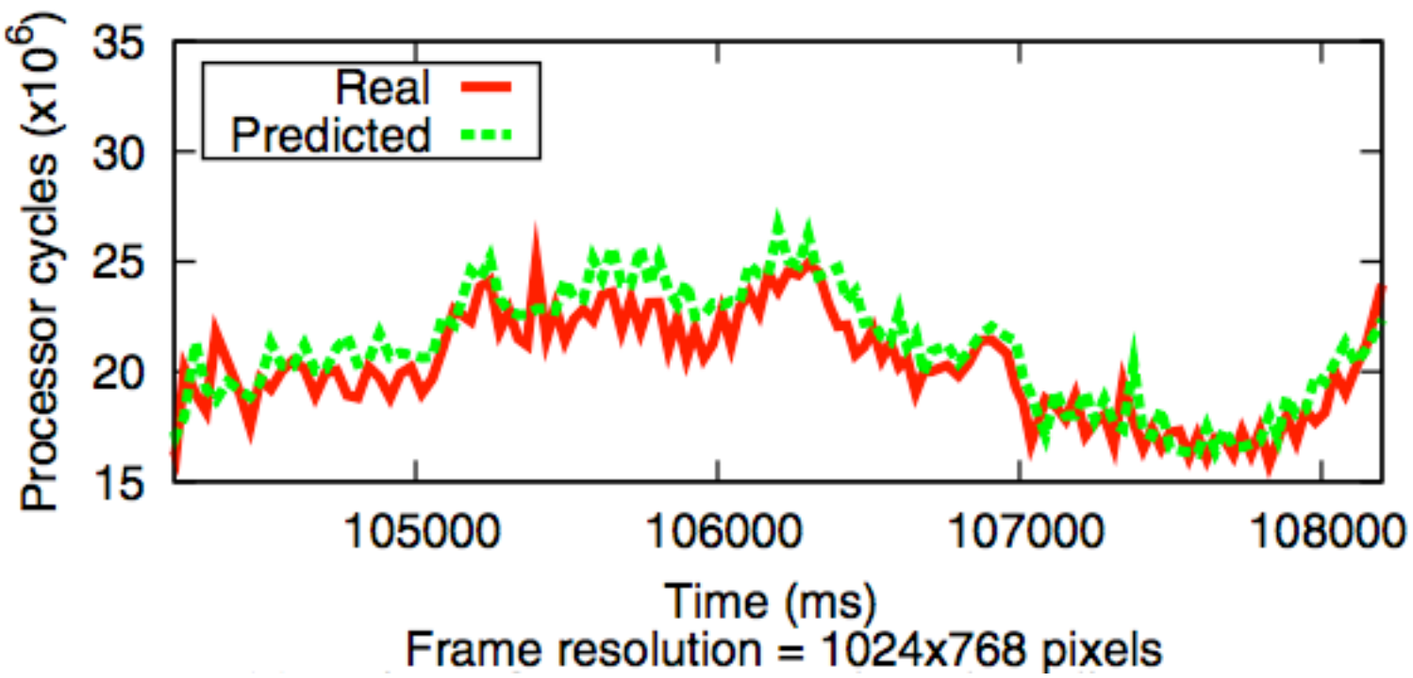


Rasterization workload for "brush model" (walls, floor, objects etc)



Rasterization workload for “alias model” (monsters, soldiers, weapon etc)


Processor cycles (x10^6)
45
40
35
30
25
20
15
Real
Predicted
88000 88500 89000 89500 90000 90500 91000 91500 92000
Time (ms)
Frame resolution = 1024x768 pixels


Processor cycles (x10^6)
35
30
25
20
15
Real
Predicted
105000
106000
107000
108000
Time (ms)
Frame resolution = 1024x768 pixels

Save power by 15% on a PDA running at 5 fps

But real games use GPU,
not CPU to render

Reducing Mobile GPU's Power Consumption

remain open!