

LongRun™

Adaptive Power Management Technology for Mobile Platforms

Marc Fleischmann
Software Program Manager
Transmeta Corporation



Crusoe, LongRun and Code Morphing
are trademarks of Transmeta Corp.
Pentium, Pentium Pro, Pentium II and Pentium III
are registered trademarks of Intel Corp.

Platform
2000

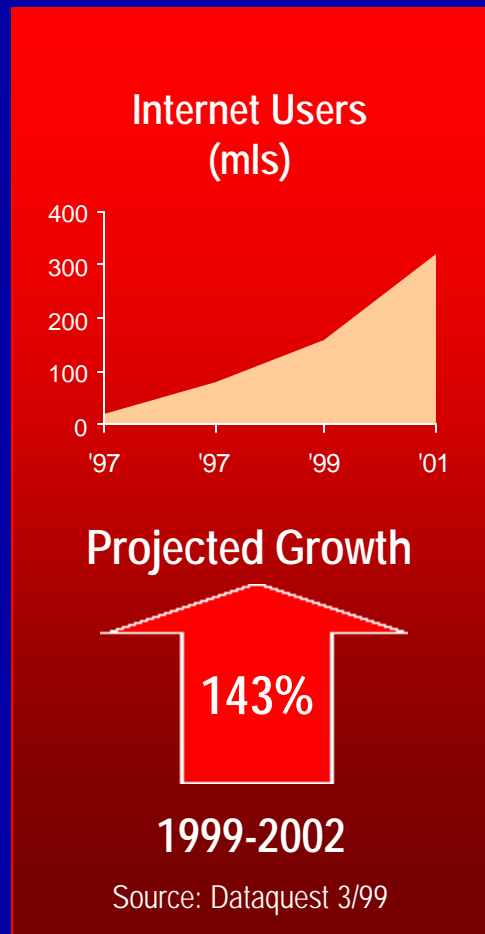
Agenda

- ◆ **Key Challenges for Mobile Computing**
 - ◆ Portability and ease of use
 - ⇒ Power is the fundamental problem
- ◆ **Crusoe™ TM3120**
 - ◆ Full compatibility with traditional x86 power management model
 - ◆ At significantly lower power
- ◆ **Crusoe™ TM5400**
 - ◆ LongRun™ Adaptive Power Control
 - ◆ Leverage “smart CPU” to drive breakthrough power savings

Market Trends

The Internet Transforms the PC Market

Growth



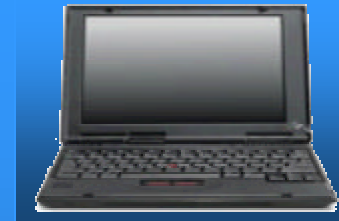
Capabilities



Thin & lights and Mini-Notebooks will be 65% of market by 2002

Thin & light becoming even thinner:
1-1.5" today
.85-1.25" in 2002

User Demands



Ease of use
93% say their battery "doesn't last long enough"

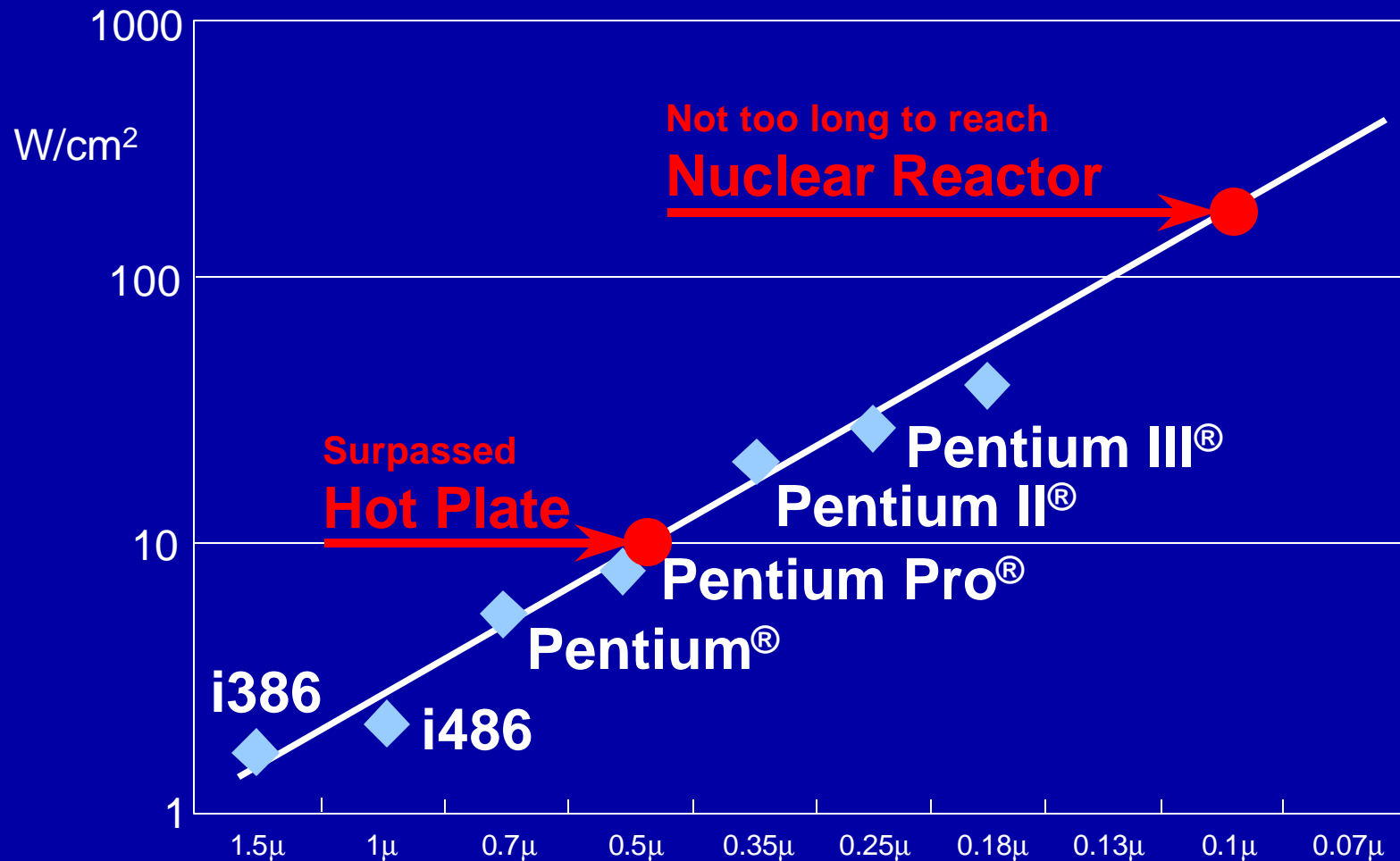
Portability
82% say their systems are "too heavy"

Source: IDC 12/99

Truly Mobile Platforms

- ◆ **Full x86 Compatibility**
 - ◆ **Enable the full PC and Internet experience**
 - ◆ **Run all x86 applications and plug-ins**
- ◆ **Performance on Demand**
 - ◆ **Delight end-users with excellent performance**
- ◆ **Energy Efficiency**
 - ◆ **Deliver long battery life and light weight**
- ⇒ **The Full PC and Internet Experience**
 - ◆ **Anywhere and anytime**

The Problem ... Power Density



Source: Fred Pollok, Intel. New Microprocessor Challenges in the Coming Generations of CMOS Technologies, Micro32

The Solution ... Use Software

The Software-Based Microprocessor

$$Power = c \times v^2 \times f$$

- ◆ **Innovation - Code Morphing™ Software**
- ◆ **Effect - Replace Millions of Logic Transistors**
 - ◆ ... and transistors translate into capacitance (*c*)
- ◆ **Benefit - Significantly Reduces Power Consumption of x86 Power States**

Traditional x86 Power Management

Crusoe Delivers Substantial Power Reduction

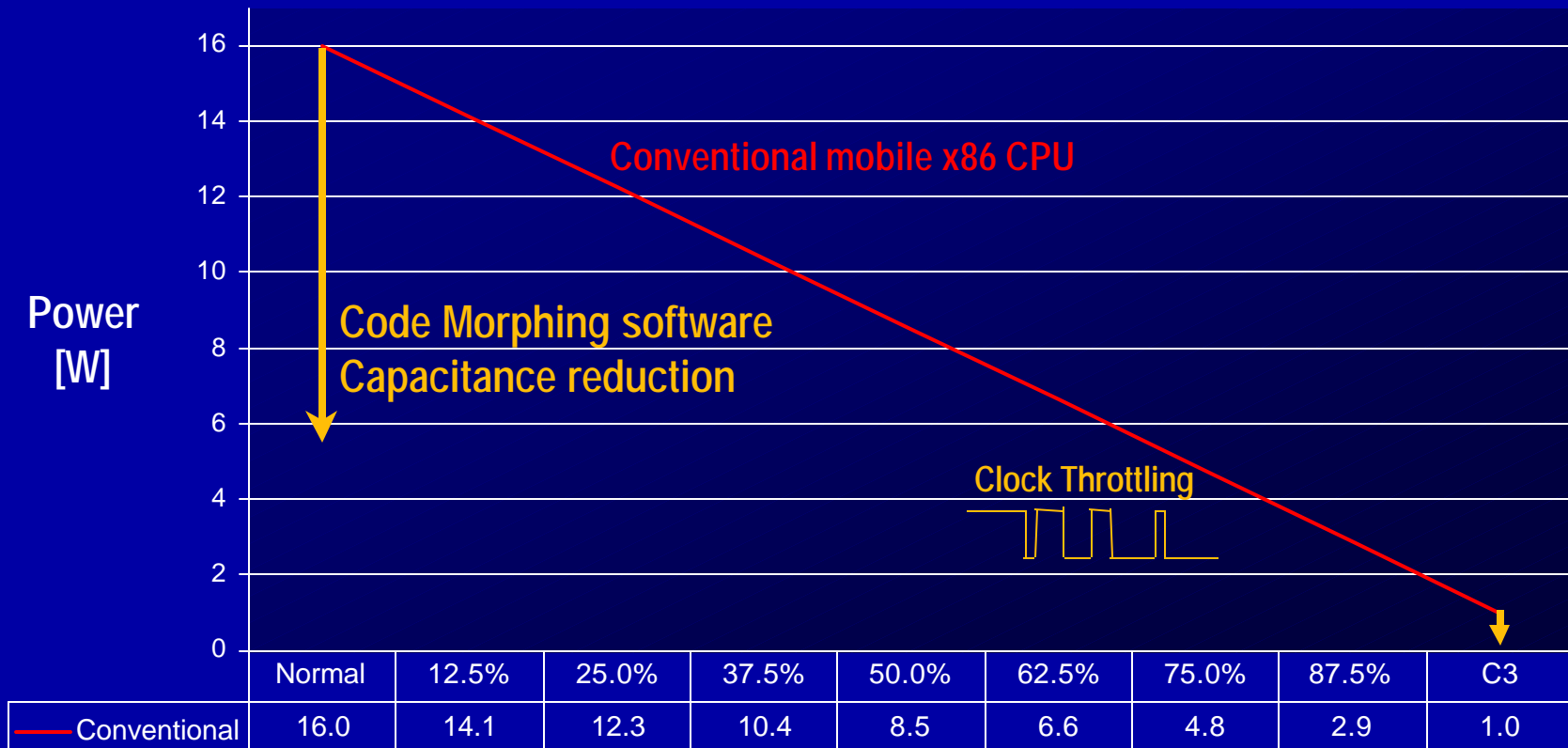
| | Conventional Mobile x86 Solution | | | Crusoe™ Integrated North Bridge | |
|------------------|--|------------------------|-------------|---|---|
| | Processor 650 / 500 MHz 1.6 / 1.35 V | North Bridge 1.35 V | Total | TM3120 400 MHz 1.5 V ¹ | TM5400 LongRun™ 667 ⇔ 266 MHz 1.625 ⇔ 1.1 V ¹ |
| Normal (C0) | 14.0/8.0 W | 2.0 W | 16.0/10.0 W | 3.5 W | 5.5 ⇔ 1.5 W |
| AutoHALT (C1) | 1.1 W | 2.0 W | 3.1 W | 0.9 W | 0.9 W |
| Quick Start (C2) | 0.8 W | 2.0 W | 2.8 W | 0.4 W | 0.3 W |
| Deep Sleep (C3) | 200 mW | 700 mW | 900 mW | 20 mW | 30 mW |

Notes

¹ TM3120 production silicon, TM5400 pre-production silicon

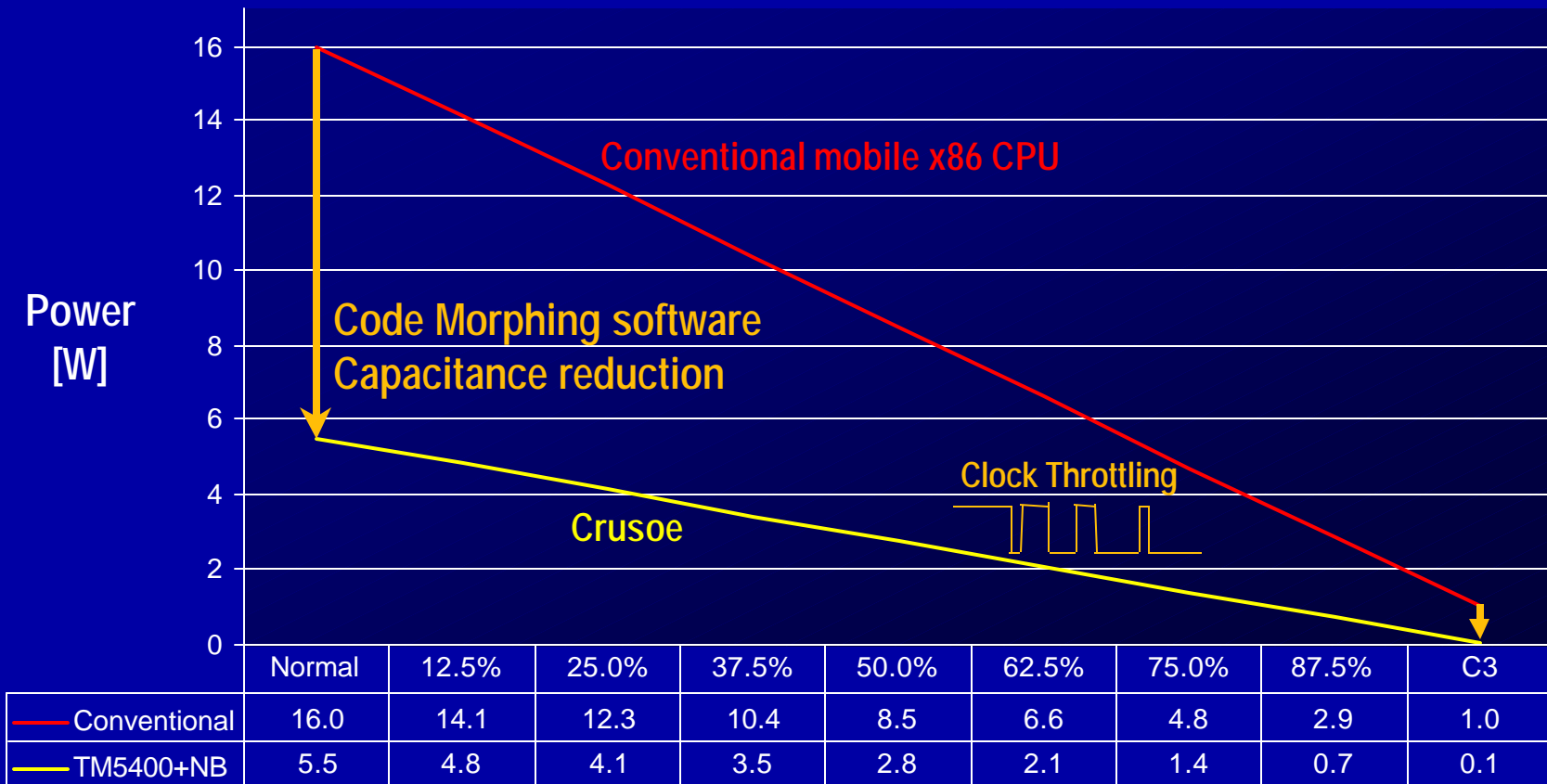
Traditional x86 Power Management

Crusoe Delivers Substantial Power Reduction



Traditional x86 Power Management

Crusoe Delivers Substantial Power Reduction

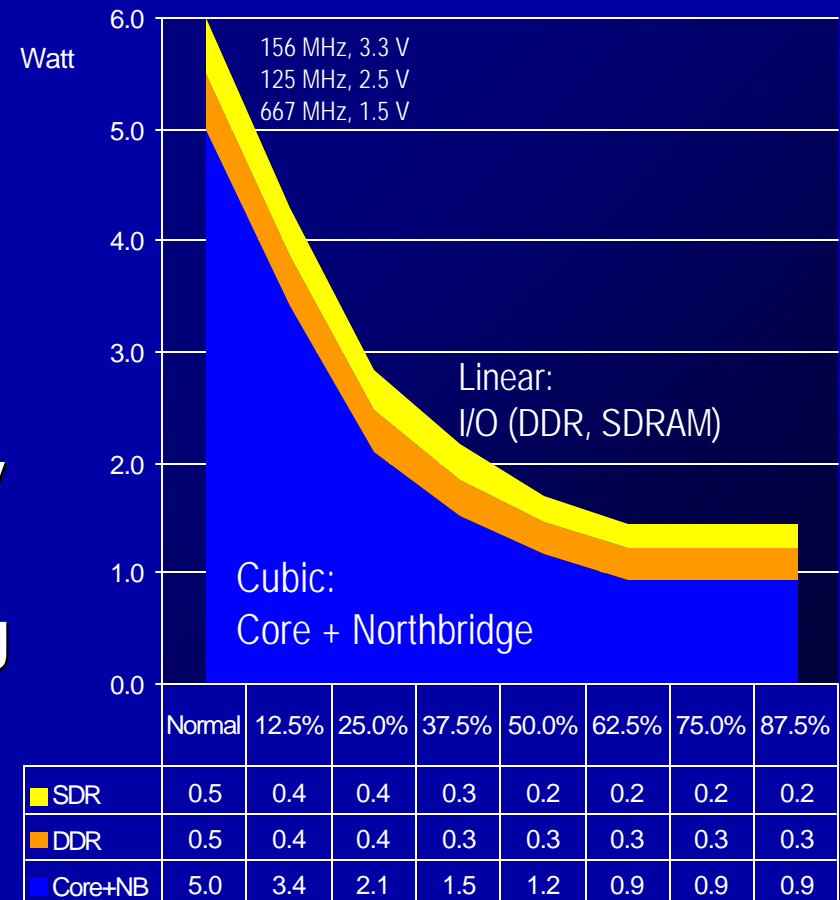


LongRun Adaptive Power Control

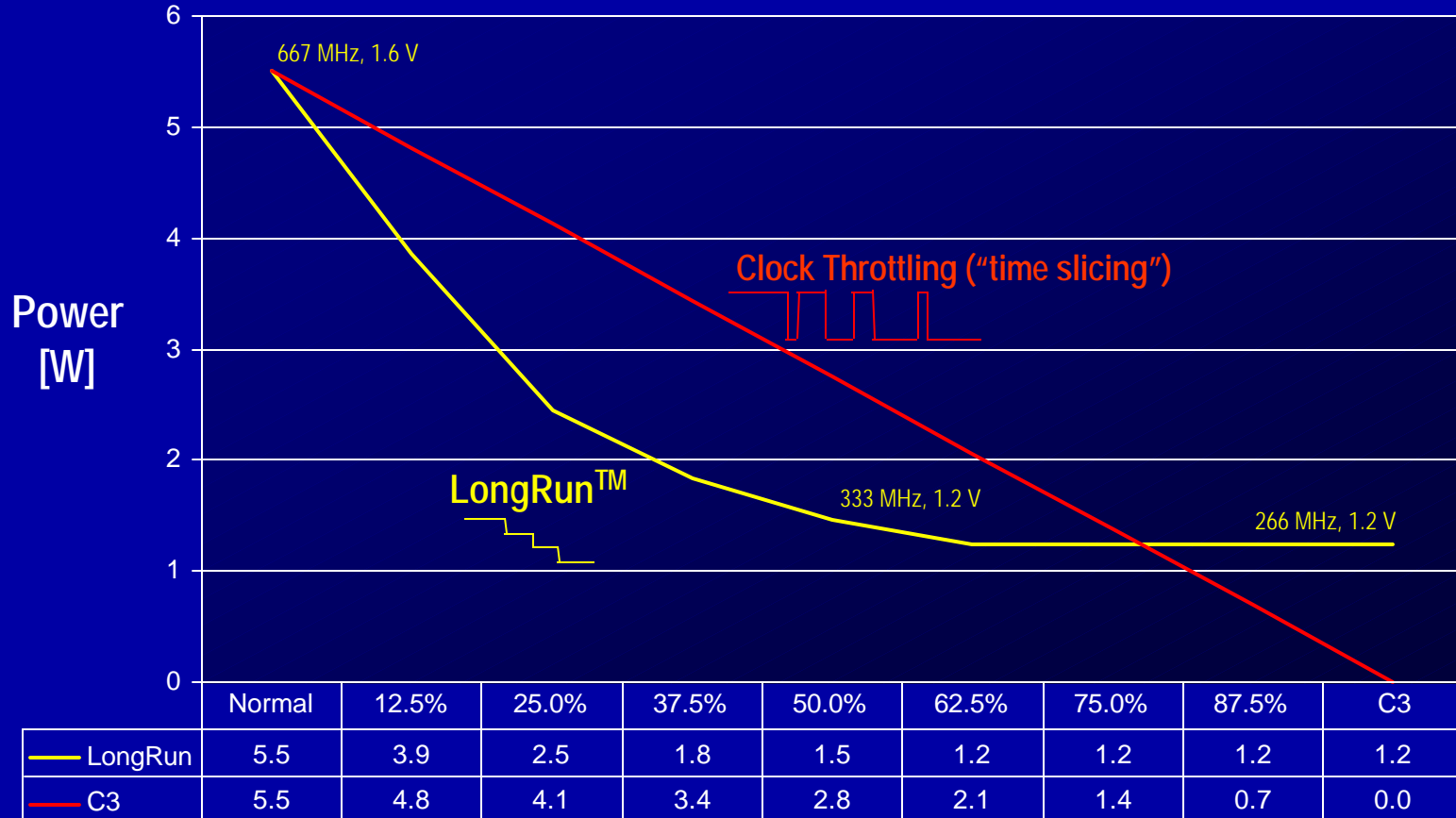
Maximize Battery Life with Performance on Demand

$$Power = c \times v^2 \times f$$

- ◆ Dynamically adapt both frequency and voltage to performance demands
- ◆ Mechanisms in CPU - fully programmable
- ◆ Policies in Code Morphing
 - ◆ Adapt f to demand
 - ◆ Reduce v proportionally
 - ⇒ Cubic power savings!



LongRun Adaptive Power Control vs. Traditional Power Management

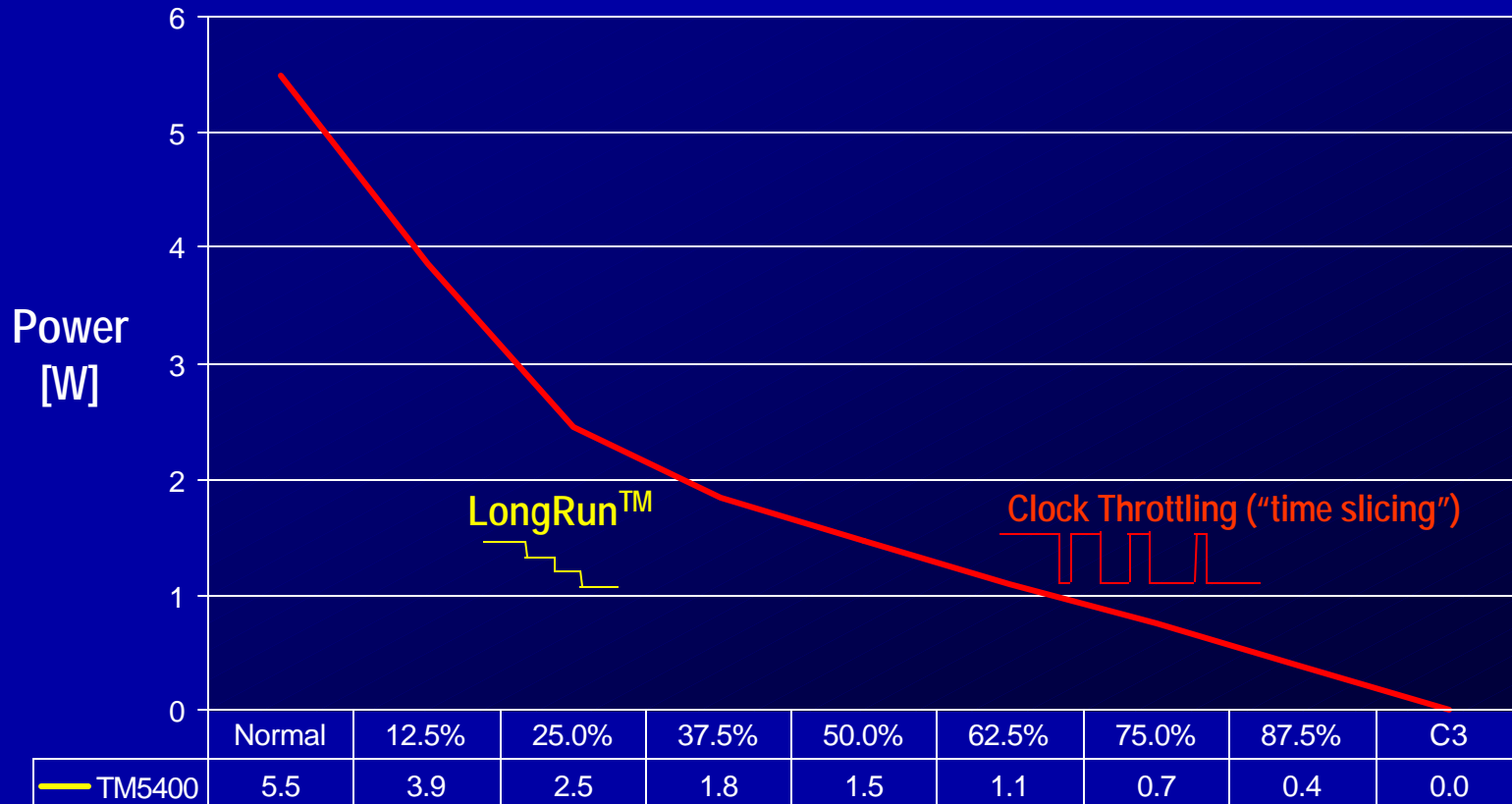


Notes

¹ TM5400 pre-production silicon

² Power numbers include Northbridge

LongRun Adaptive Power Control Crusoe Power Profile

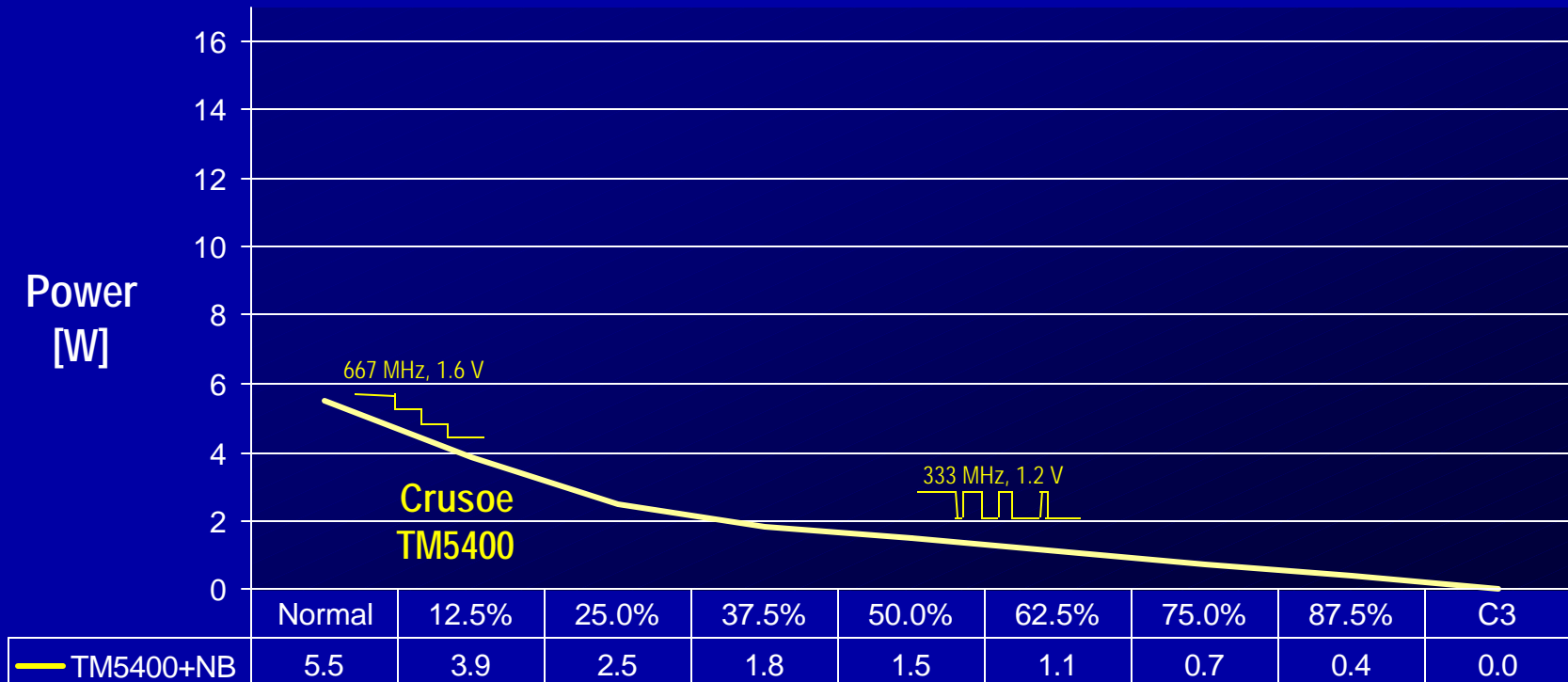


Notes

- 1 TM5400 pre-production silicon
- 2 Power numbers include Northbridge

The LongRun Effect

Power Profiles

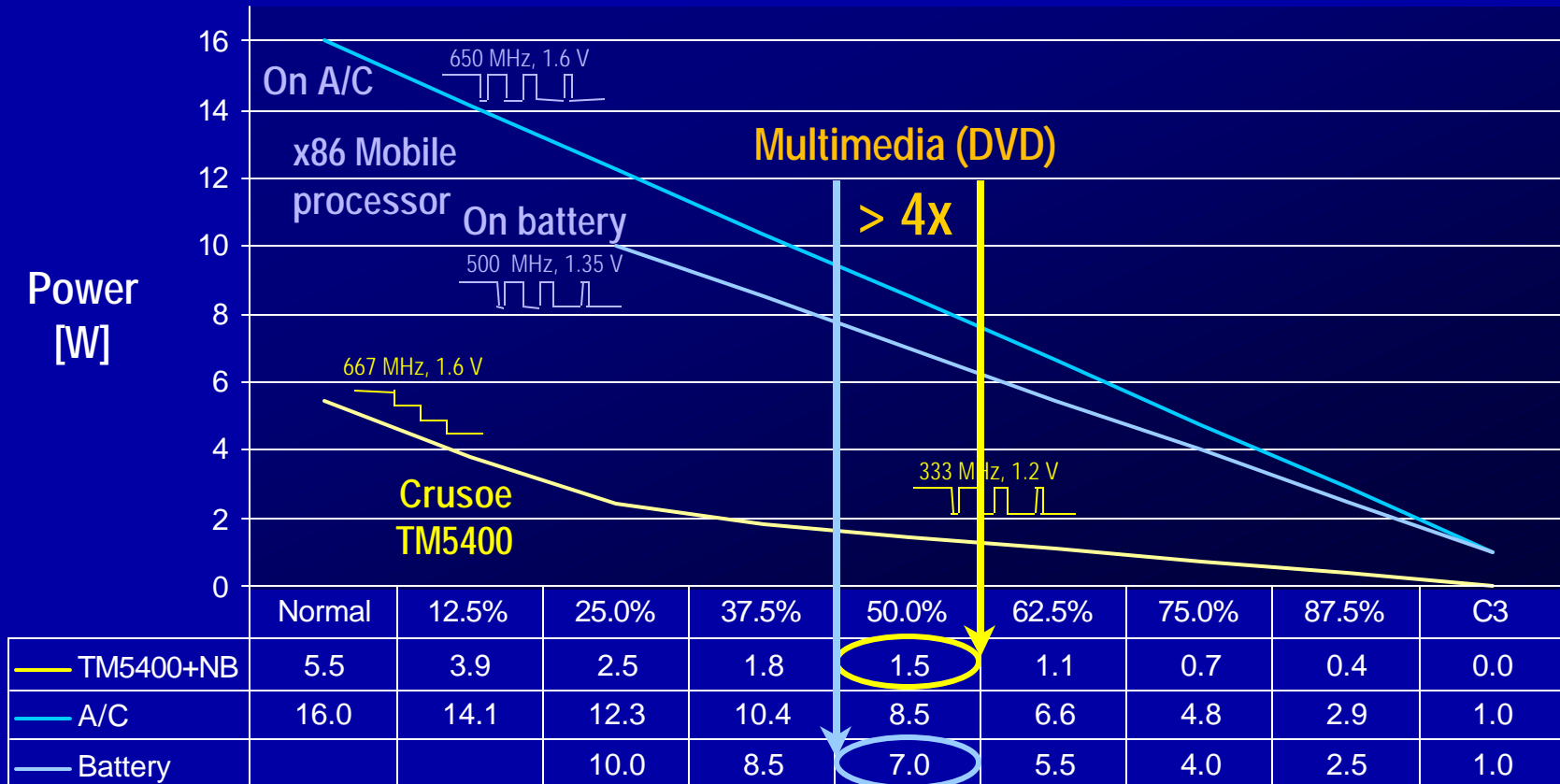


Notes

- 1 TM5400 pre-production silicon
- 2 Power numbers include Northbridge

The LongRun Effect

Power Profiles



Notes

- 1 TM5400 pre-production silicon
- 2 Power numbers include Northbridge

LongRun - How does it all work?

Standard Applications

No changes required

Standard Operating System

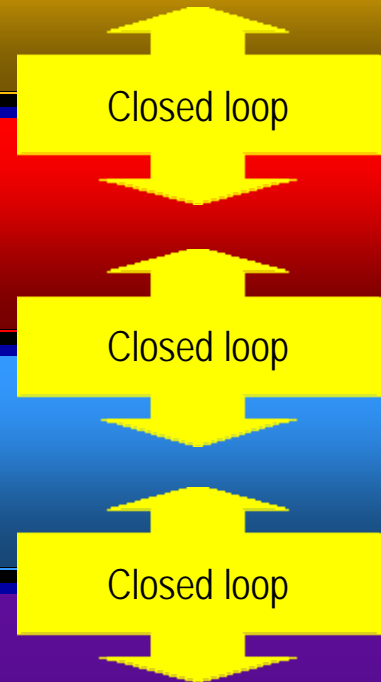
No changes required

Standard BIOS

No changes required

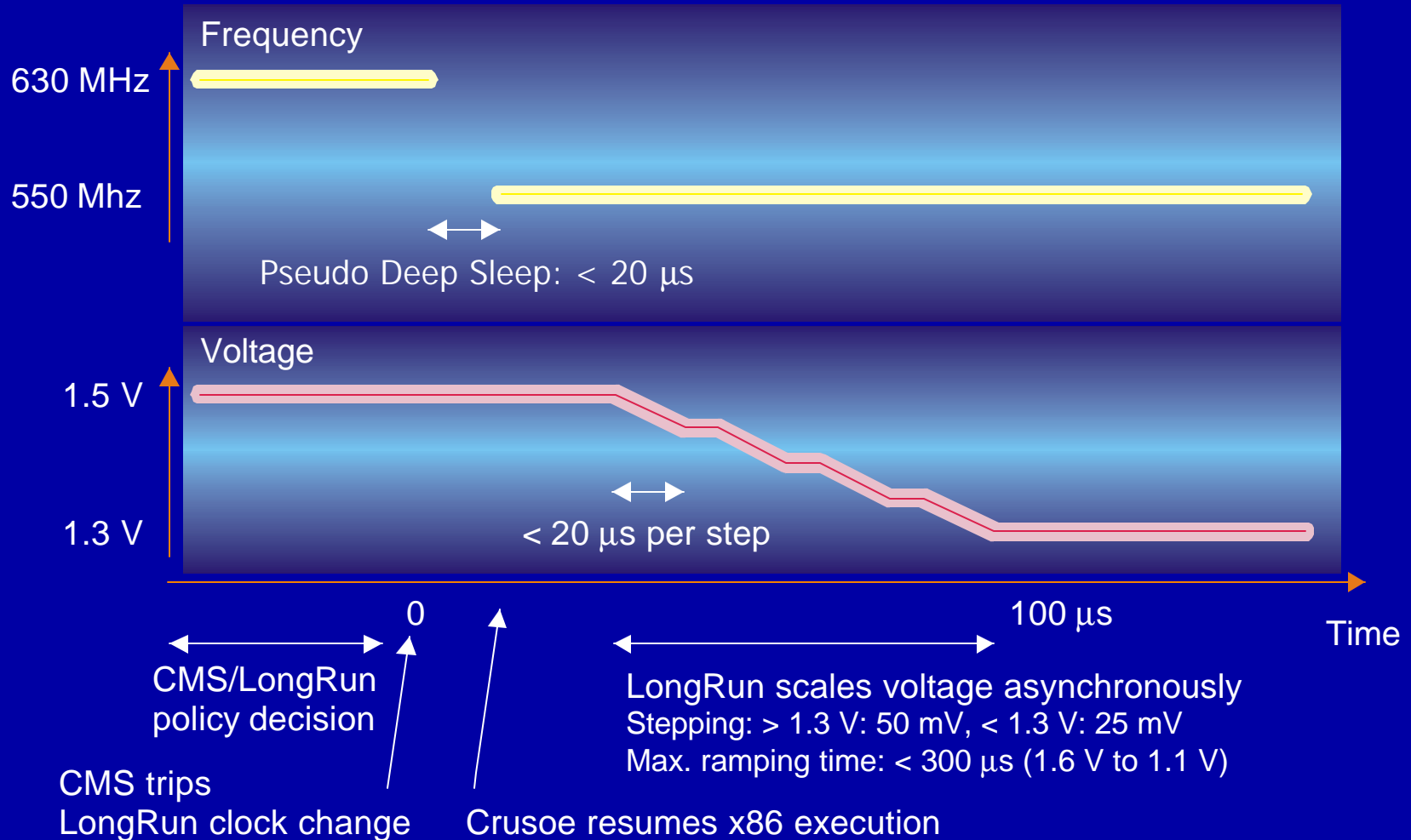
Crusoe™ TM5400 processor featuring Transmeta LongRun™ technology

Code Morphing™ software monitors system activity and dynamically adapts LongRun performance levels



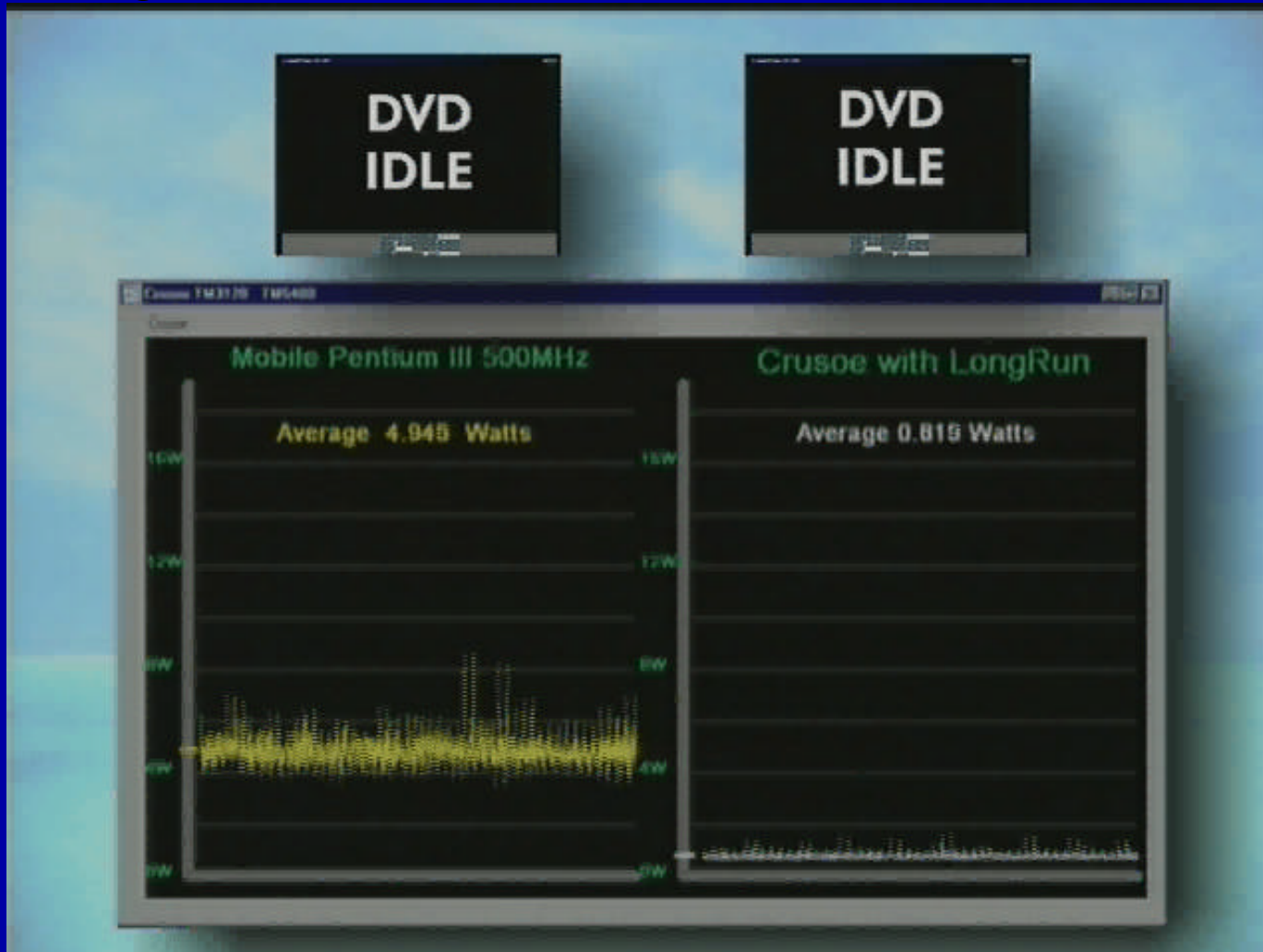
LongRun - How does it all work?

Example: 40% Power Reduction



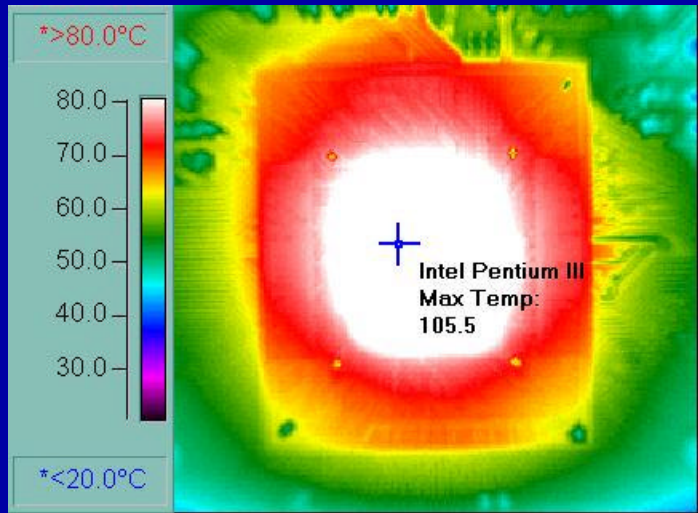
The LongRun Advantage

DVD Playback - Performance on Demand



The LongRun Advantage

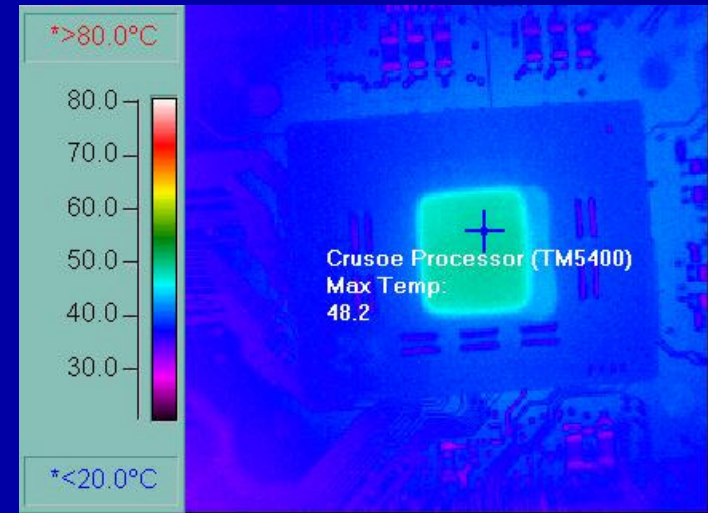
DVD Playback - Thermal Comparison



Mobile Pentium III[®]
Processor

105.5° C 221.9° F

Active thermal solution required
(Fan or overload protection)



Crusoe™ TM5400 Processor
with LongRun™

48.2° C 118.8° F

Passive thermal solution
(No fan or overload protection)

Summary

Crusoe Blends the x86 with Low Power

- ◆ Transmeta rethought the microprocessor to meet the demands of mobile users
 - ◆ Code Morphing Software
- ◆ Crusoe significantly reduces power in traditional x86 power management states
 - ◆ Normal: 2x - 3x power savings
 - ◆ Sleep: 3x - 30x power savings
- ◆ Crusoe delivers breakthrough power savings
 - ◆ LongRun Adaptive Power Control
 - ◆ Normal: 2x - 10x power savings