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usenix THE ADVANCED COMPUTING SYSTEMS ASSOCIATION

Practitioner Talks Track of the 2015 USENIX Annual Technical Conference

Faster Booting in Consumer Electronics

7/13/2015 2:48 PM

Geunsik Lim

Samsung Electronics
Software R&D Center
Frontier CS Lab.

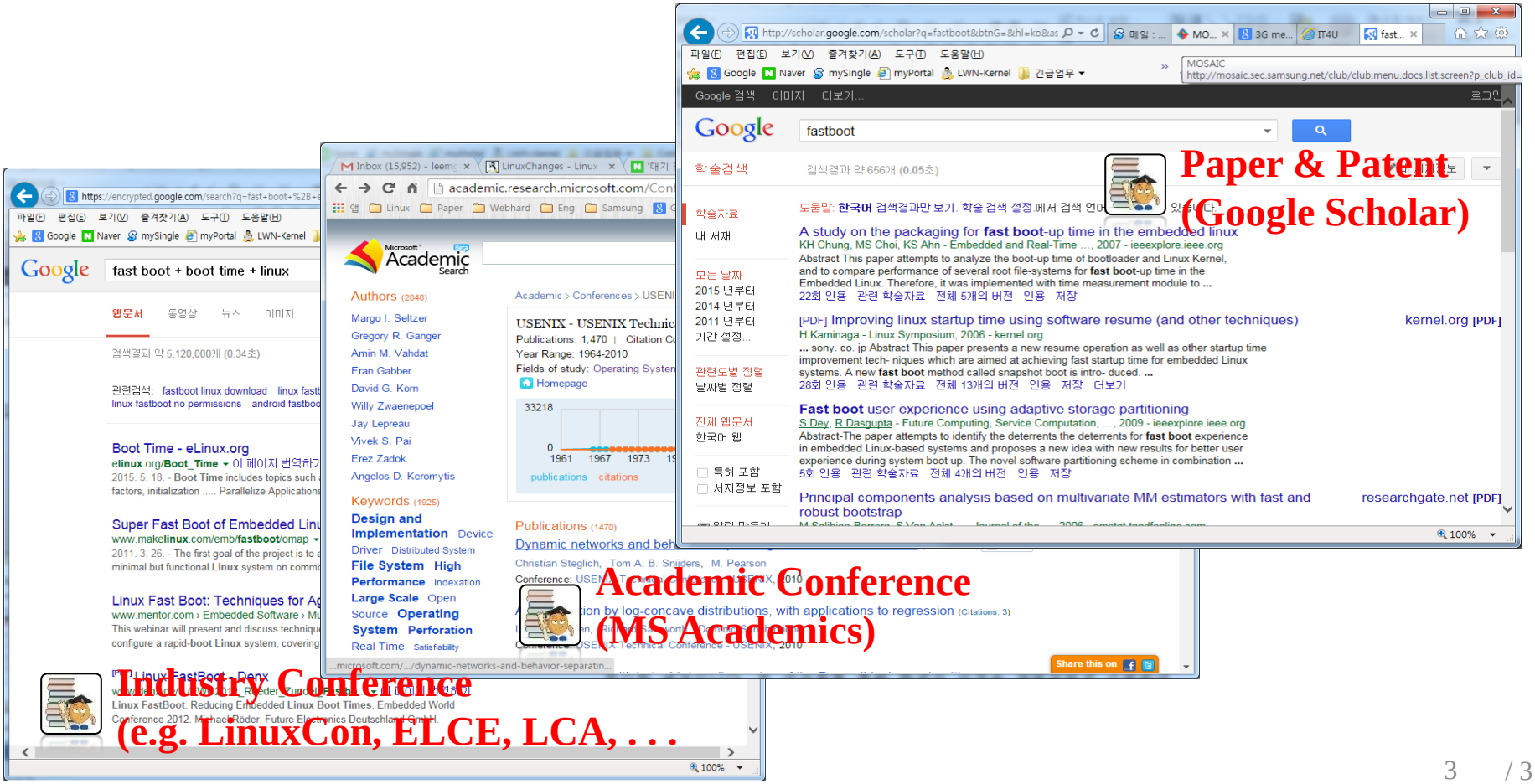
SAMSUNG

Outline

- **Fast-boot Overview in Industry**
- Optimization for Fast-boot
- New Env. and New Challenge
- Takeaway

Research Papers for Fast-boot

- There are a lot of papers for improving startup time in CE devices
- Let's find edible fruits from research papers



➢ **CE: Consumer Electronics**

Technical Domains of Fast-boot

- Source - http://www.1001freedownloads.com/free-icon/cat-sleep-icon

Energy Cost in Standby Mode

- Customers still want to save money by turning their TV completely off

GoPro Camera Models

(Unit: Watts)

	HD	H2	H3W	H3S	H3+S	H3B	H3+B	H4B
Standby Photo	1.2	1.2	1.2	1.2	1.1	2.1	1.9	1.7
Standby Video	1.2	1.2	1.2	1.7	1	2.1	1.3	1.7

➢ Source - http://cam-do.com/GoProPower.html

Flatscreen TVs(2011)

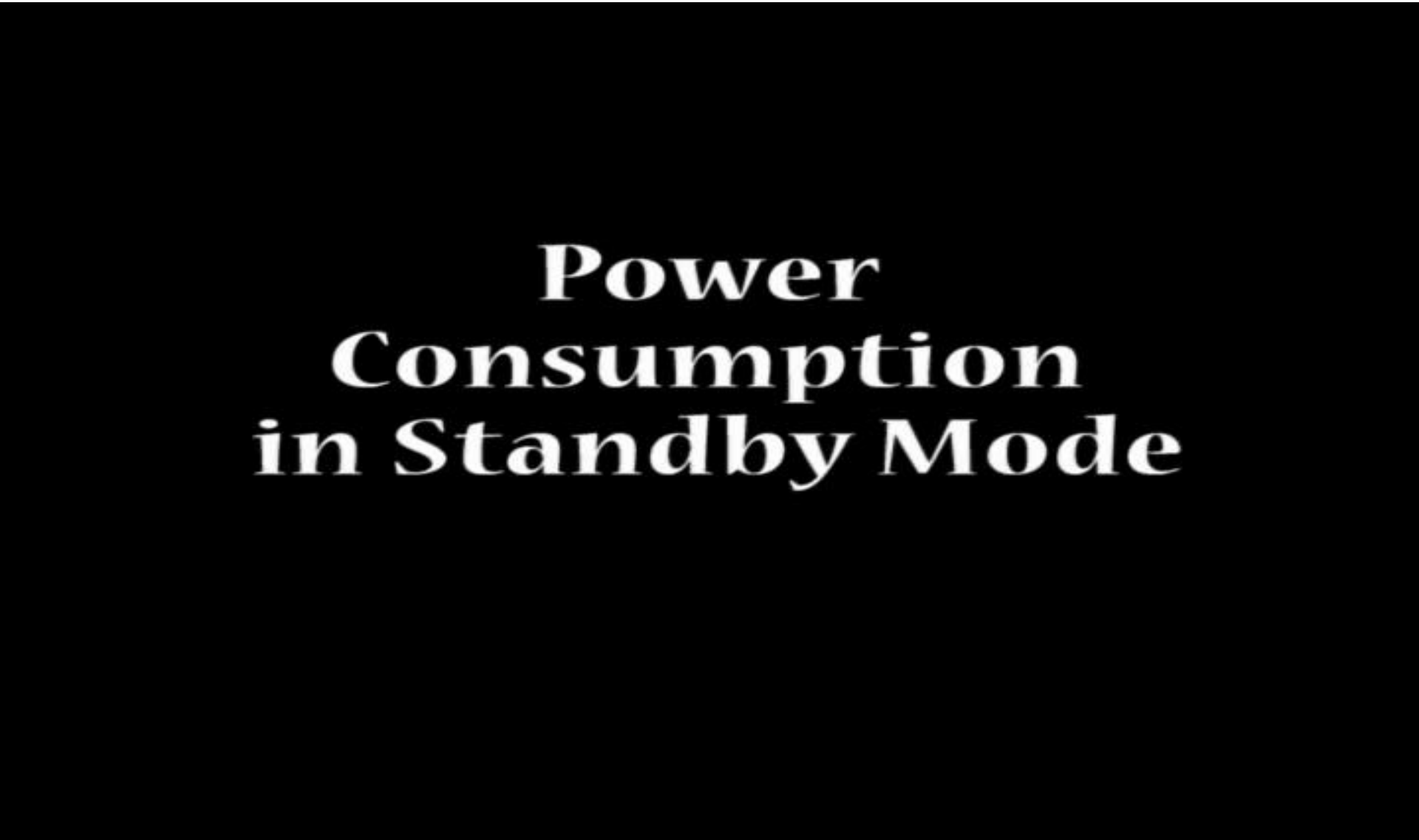
(Unit: Watts)

Panasonic Viera TX-L32E3B	38.5W	0.2W
LG 32LV450	46.0W	0.1W
Sony Bravia KDL-32EX523	48.9W	0.2W

➢ Source - http://blogs.which.co.uk/technology/tvs/still-using-a-big-box-tv-why-the-energy-costs-may-make-you-think-again

Customer Suspects Energy Efficiency

- Video: **High standby power consumption** from some TV models

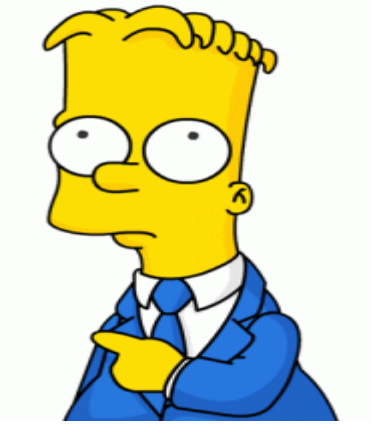


Why is Cold Boot Important in CE?

- Source - http://www.etfguide.com/watch-out-the-stock-market-is-slow/

Continuous Complaints of Customer

Customers



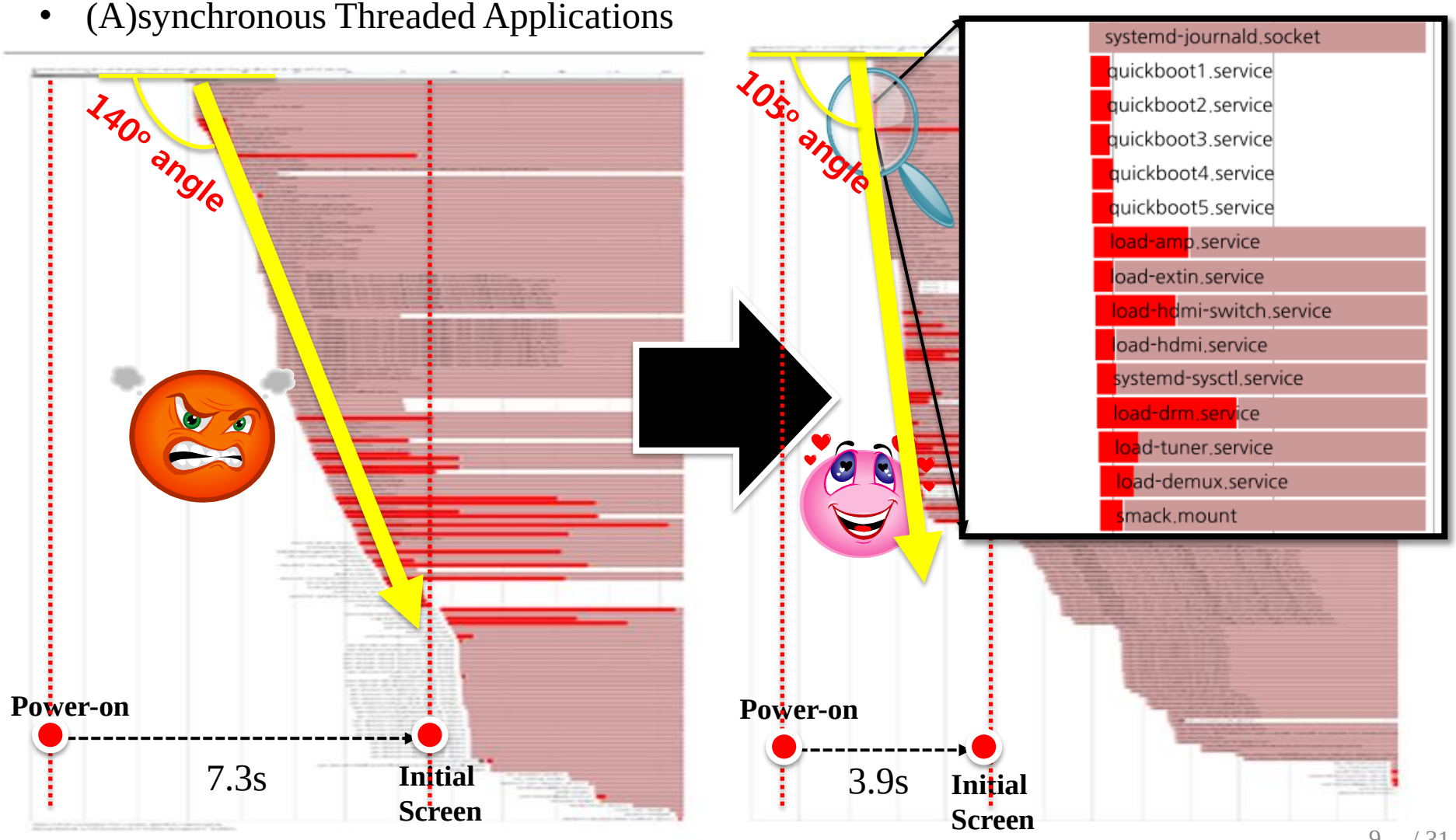
Manufacturer

20th Century Fox Television

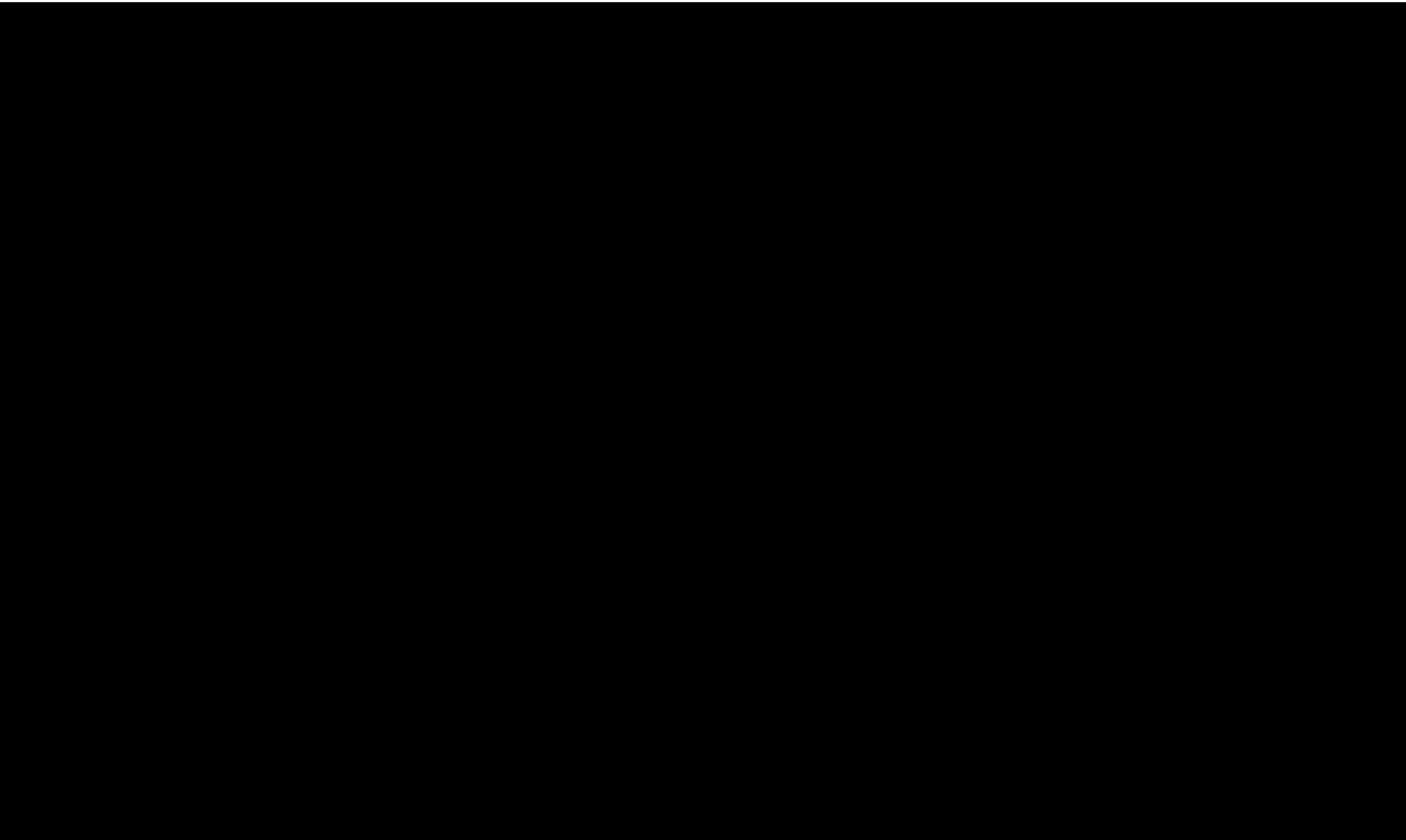
- Source - http://pugetsoundblogs.com/kitsap-caucus/2010/02/02/now-angel-wants-you-to-phone-it-in/
- Source - http://malikaziz.com/2014/12/10/my-2nd-favorite-simpsons-gag/

Improving Boot-up Time from Cold Boot

- Cold-boot Based Fast-boot Techniques
- (A)synchronous Threaded Applications
- Parallel Execution with Multi-core CPUs



Video Demonstration (Tizen TV)



Video Demonstration (Camcorder)

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- **Optimization for Fast-boot**
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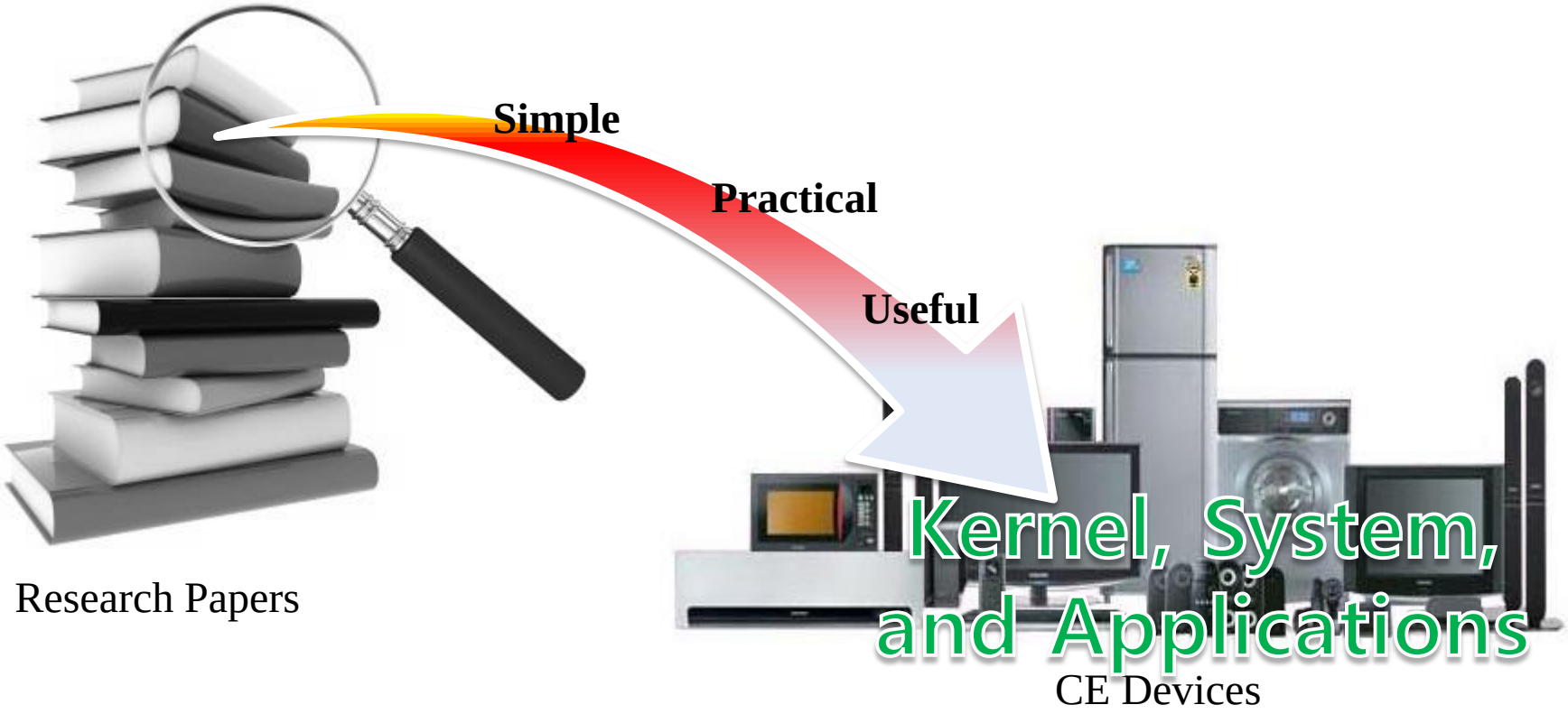
Techniques that We Applied?



Research Papers

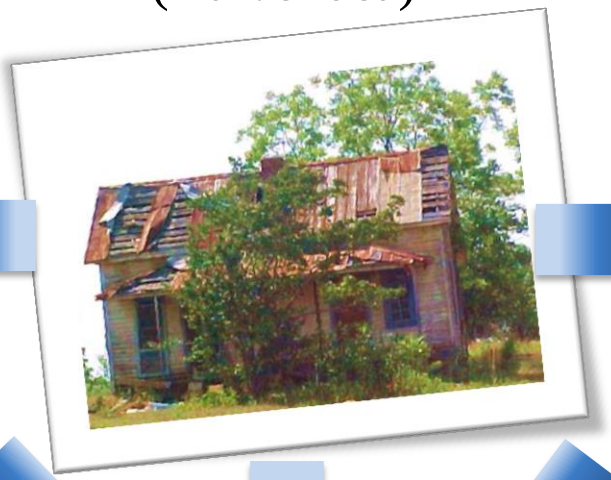
CE Devices

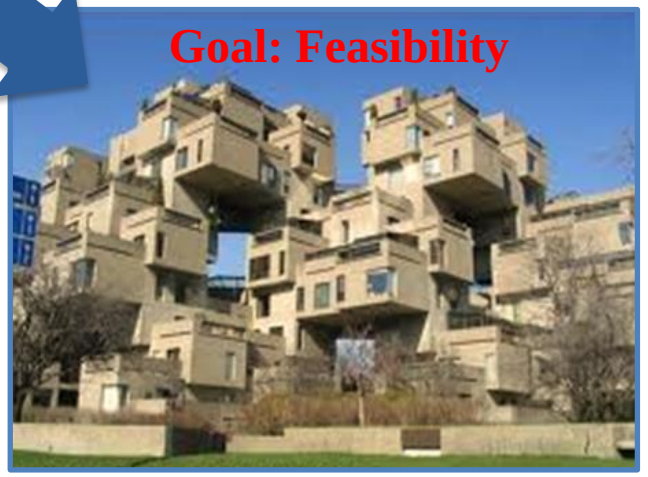
Practical Researches

Practical idea
(Simple)

Existing system
(Naïve idea)

Disruptive idea
(Persistent OS)





Out of scope

Cosmetic
(Turning & Tweaking)

Aggressive idea
(Suspend-to-disk)

- Source http://www.poorhousestory.com/poorhouses_in_alabama.htm
- Source http://www.longfenceandhome.com/house-siding

How? (Kernel)

Modulation of kernel subsystem

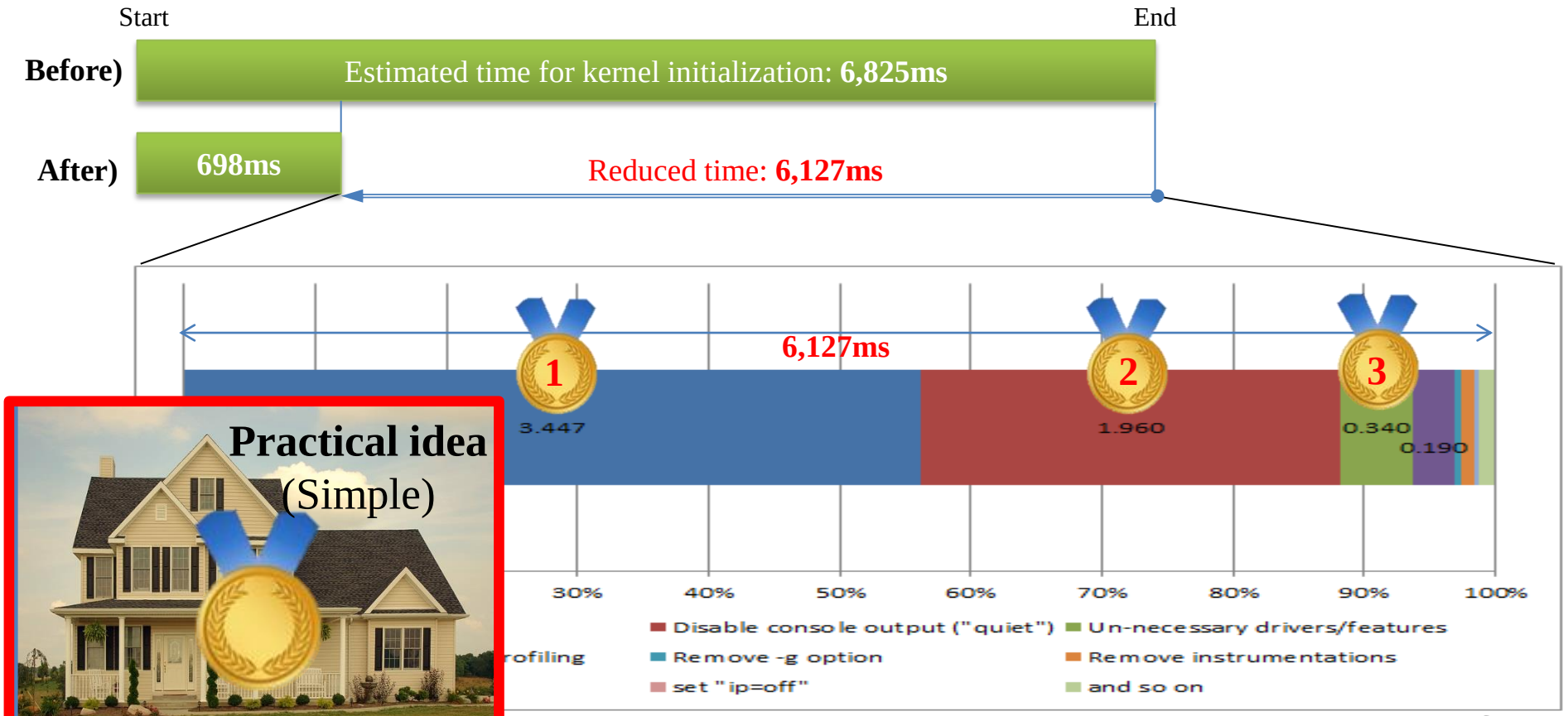
Quiet console for small memory foot-prints

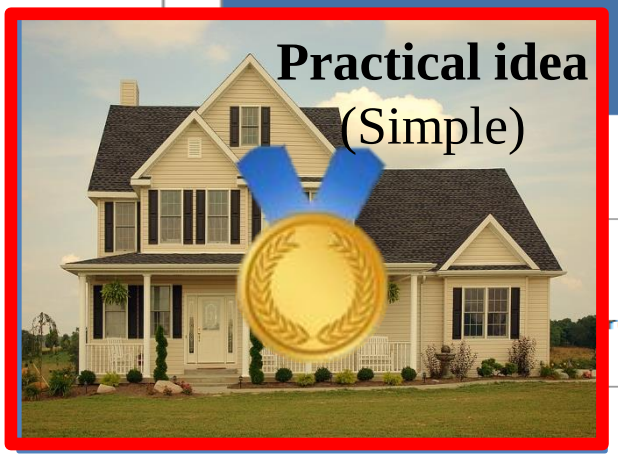
Eliminating unused drivers and features

- Tiny kernel
- Compressed kernel
- Deferred module initialization
- Reducing probing delays
- File-system tricks (e.g. Read-only file system)
- Asynchronous initcall

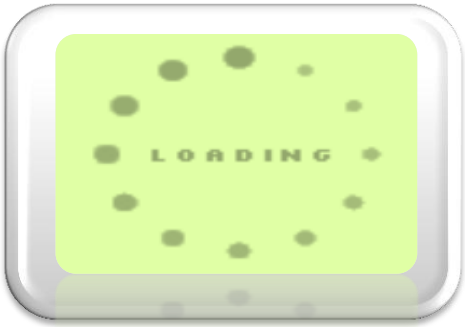
How ? (Kernel) Cont'd

- Kernel optimizations generally fall into two areas: SIZE and SPEED

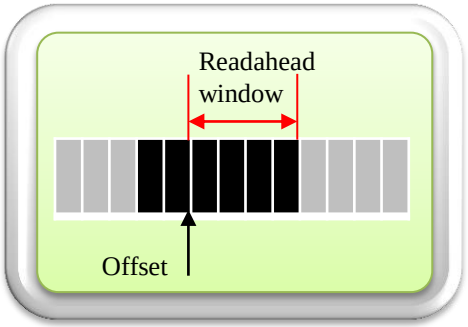




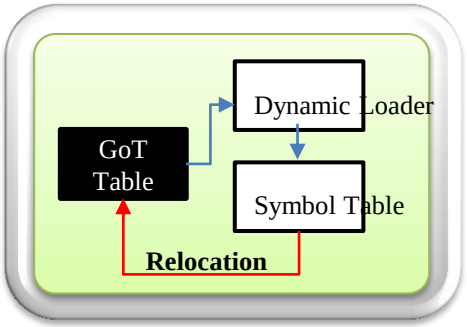
How? (System)



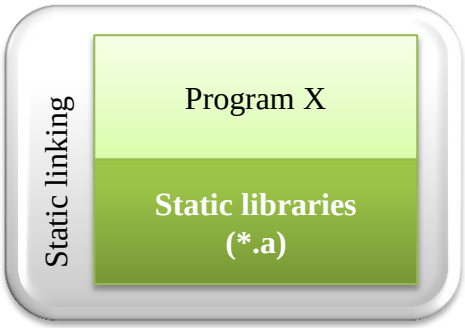
Preload



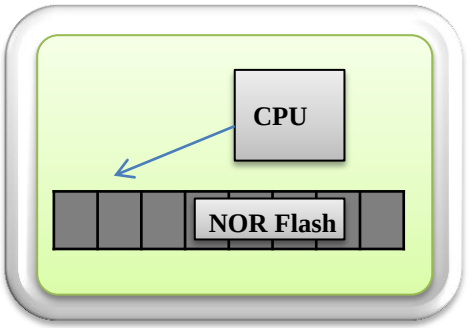
Read-ahead



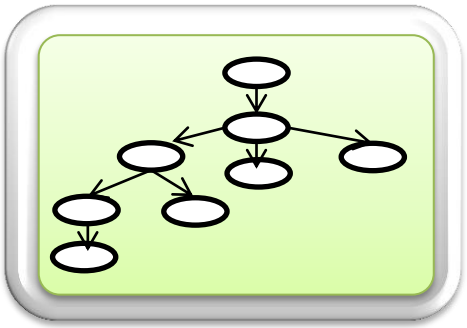
Pre-linking



Static linking
(e.g. init)

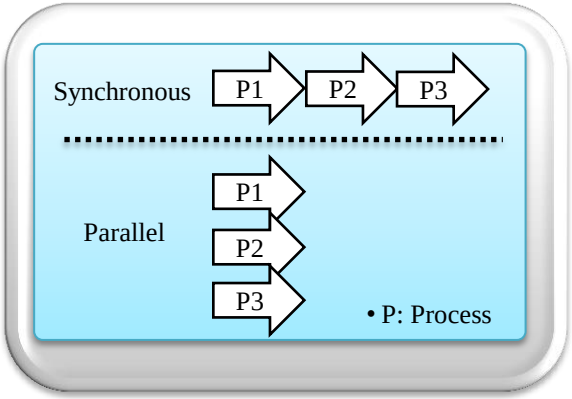


Execute In Place
(XIP)

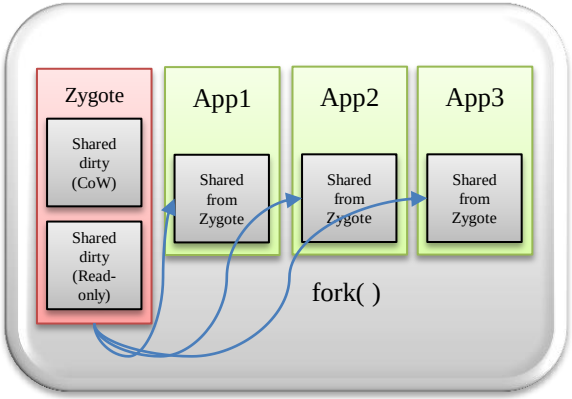


Dependency based
service execution

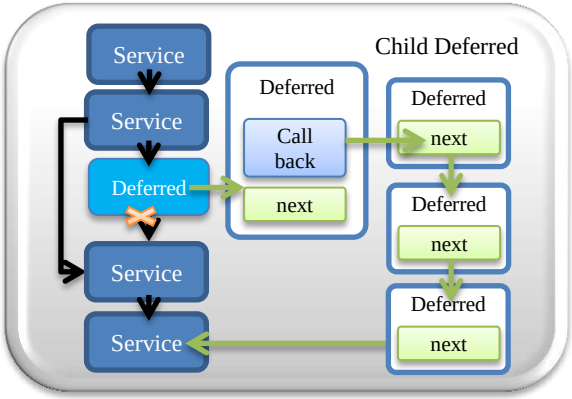
How? (Apps)



Parallel Execution



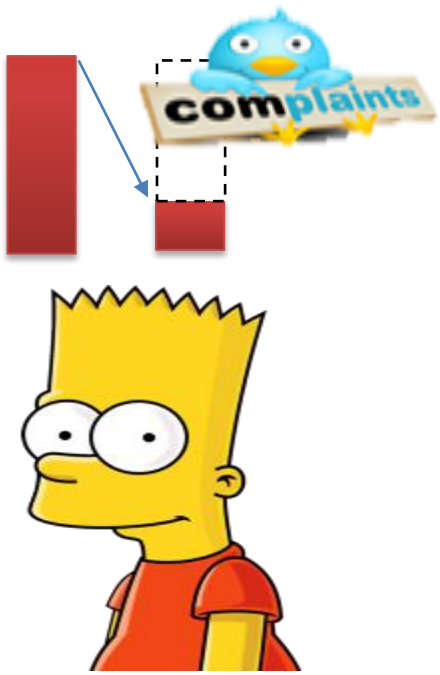
Pre-fork



Deferred Execution

Continuous Complaints of Customer

Customers



Manufacturer

20th Century Fox Television

- Source - http://therongolianstar.com/2012/11/06/31-one-liners/
- Source - http://www.iconarchive.com/show/simpsons-icons-by-jonathan-rey/Bart-Simpson-01-icon.html/

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- **New Env. and New Challenge**
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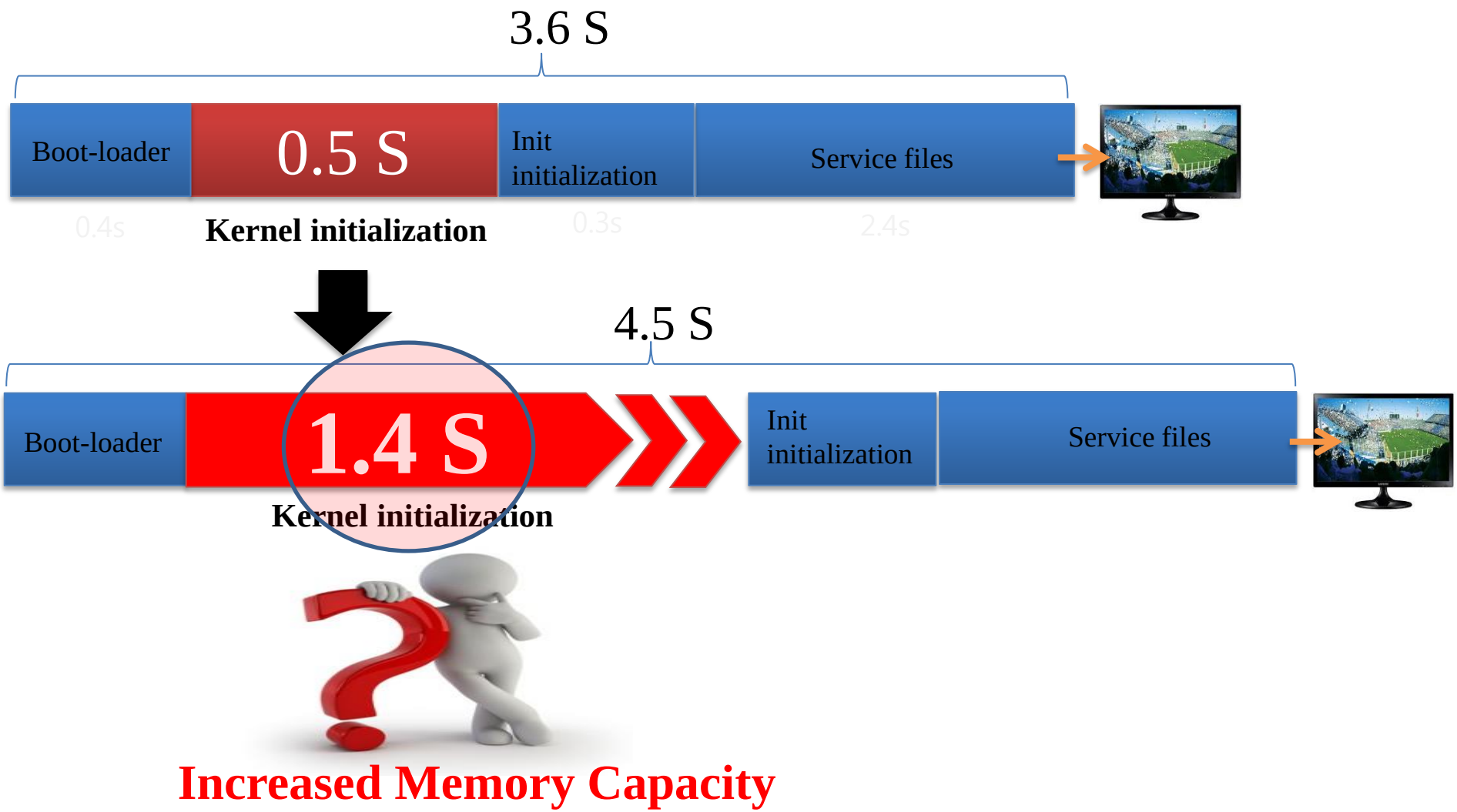
Open Problems: Big Jumps Required

- Source - http://jdblogger.com/311/jdb-005-make-the-jump-tips-on-launching-your-own-law-practice/

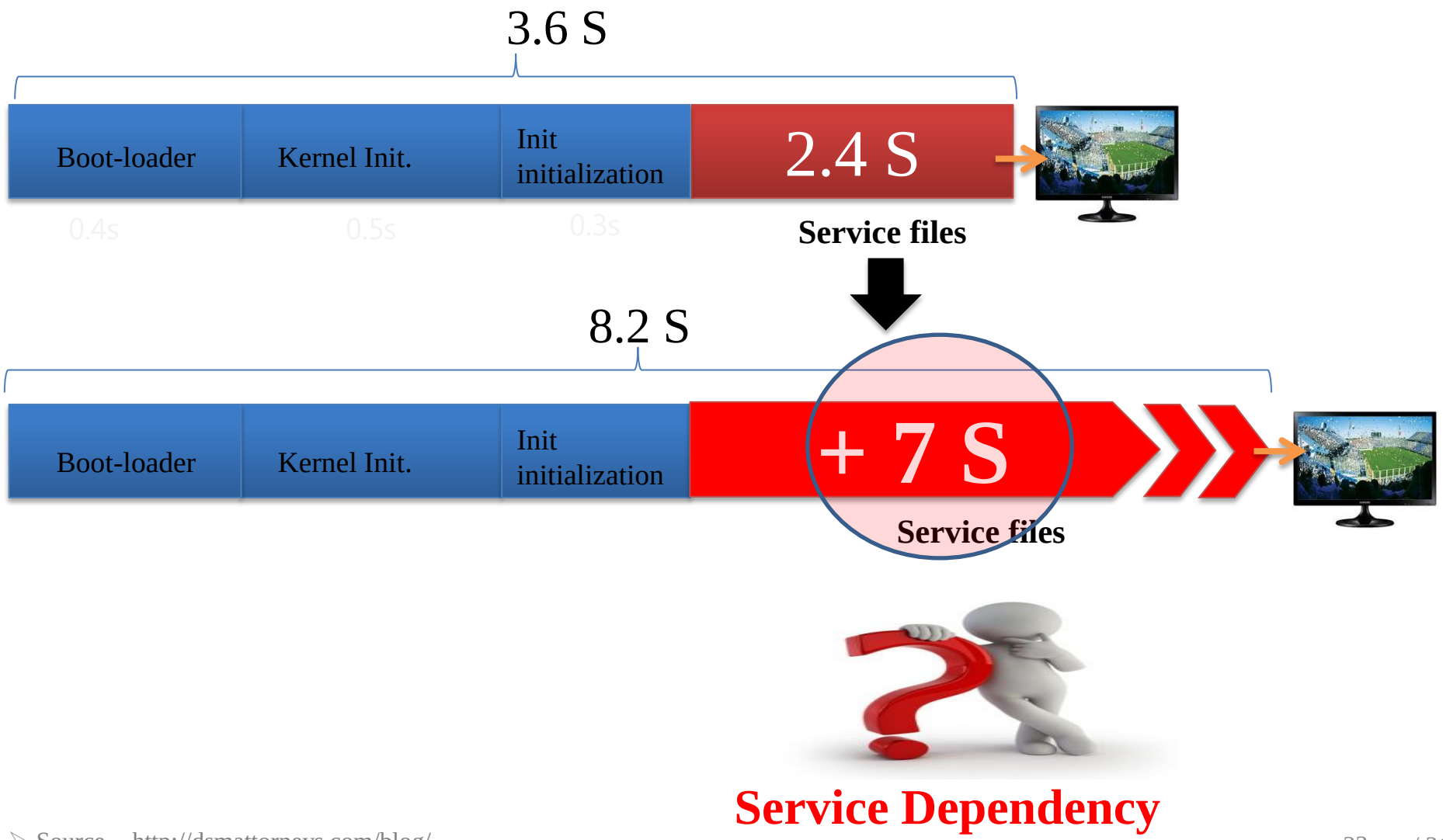
New Env. & New Challenges



Increased Memory Capacity

➢ Source - http://dsmattorneys.com/blog/

New Env. & New Challenges (Cont'd)



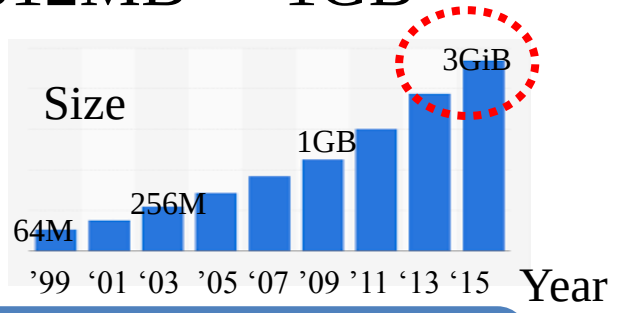
Service Dependency

➢ Source - http://dsmattorneys.com/blog/

New Challenges

Increase of the memory capacity in CE device

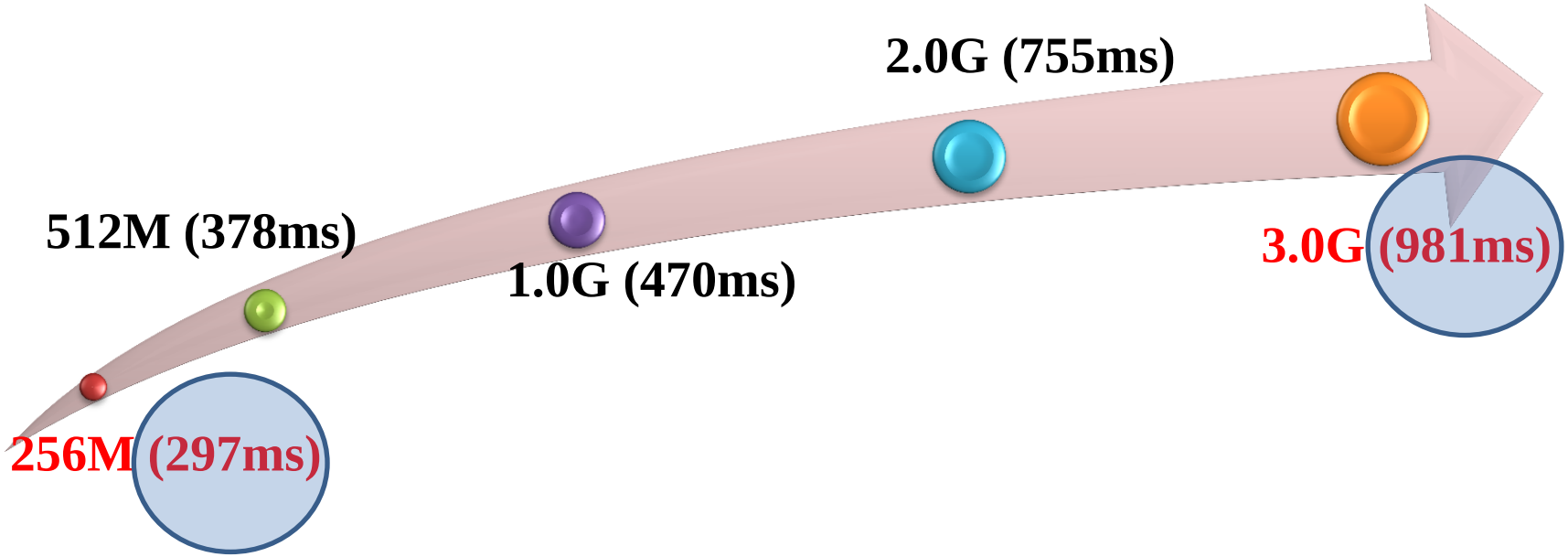
- 32bit: 64MB -> 128MB -> 256MB -> 512MB -> 1GB -> 1.5GB -> 2GB -> 3GB -> 4GB
- 64bit: 4GB -> 8GB -> 16GB -> . . . . . .



Increase of engineering cost for optimization on dependency-based 'init' scheme

- Increased dependency complexity among services
- Limitation of in-order mechanism
  - De facto standard, SYSTEMD

Case Study: Memory Initialization Cost



Increase of physical memory causes slow kernel execution at boot time

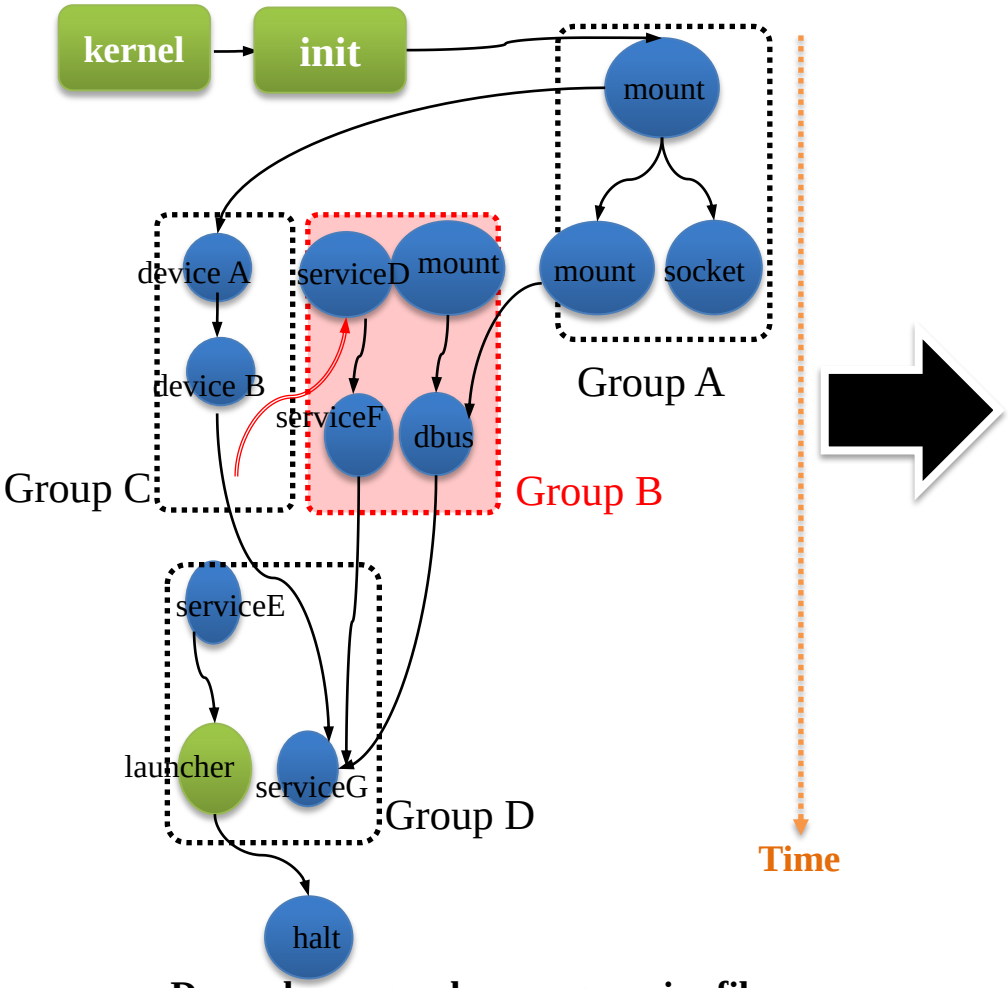
Slow kernel execution result from cost of memory initialization

Case Study: Dependency Complexity

- Administrator must know dependencies among the services
- BTW, each service is developed by application developers

Case Study: Dependency Complexity (Cont'd)

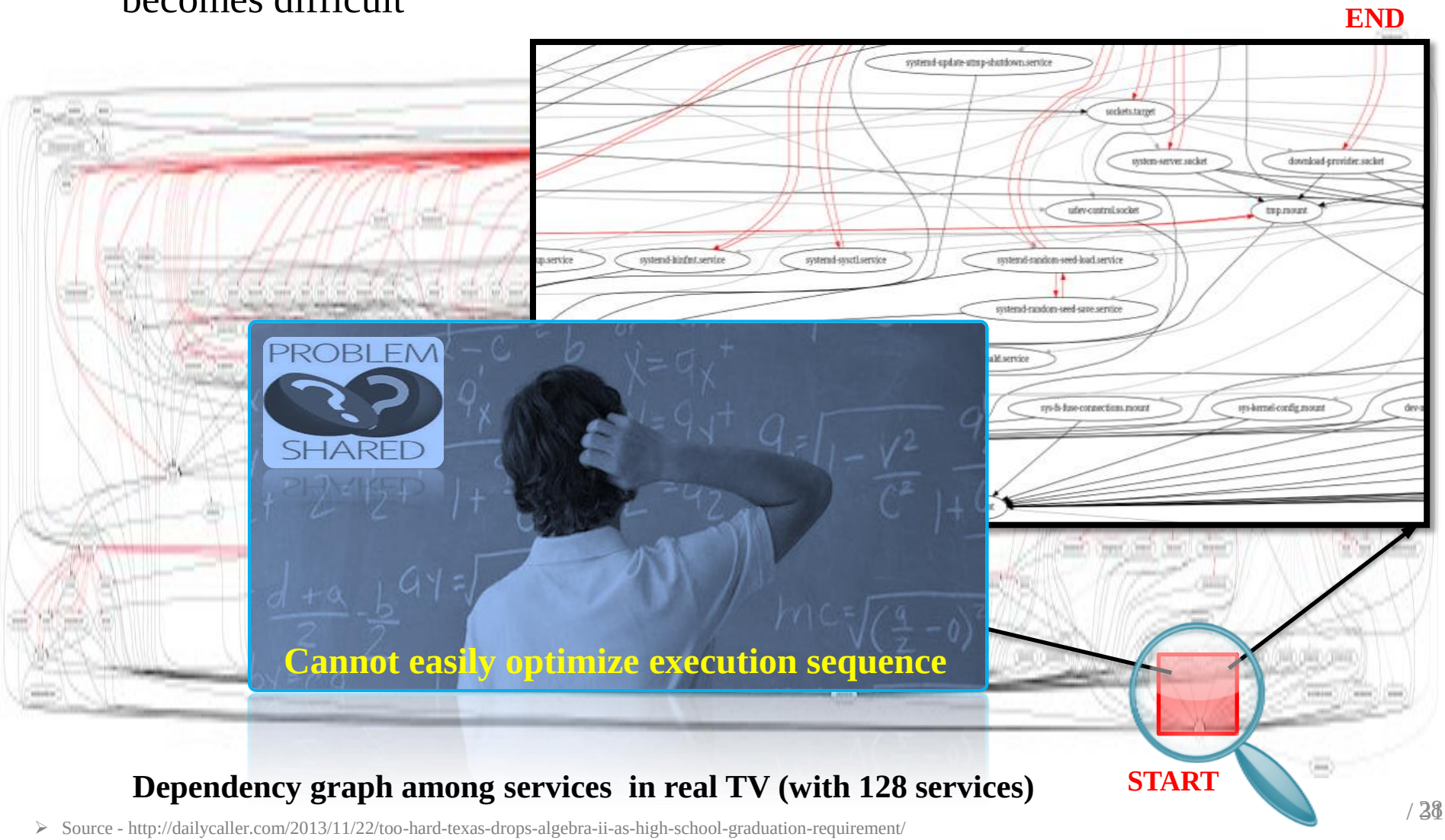
- "Group B" is separated to two "Group B"s due to dependency declaration of "service A"



Dependency graph among service files

Case Study: Dependency Complexity (Cont'd)

- The more new services make dependency relationship, the more fast-boot becomes difficult



Dependency graph among services in real TV (with 128 services)

➢ Source - http://dailycaller.com/2013/11/22/too-hard-texas-drops-algebra-ii-as-high-school-graduation-requirement/

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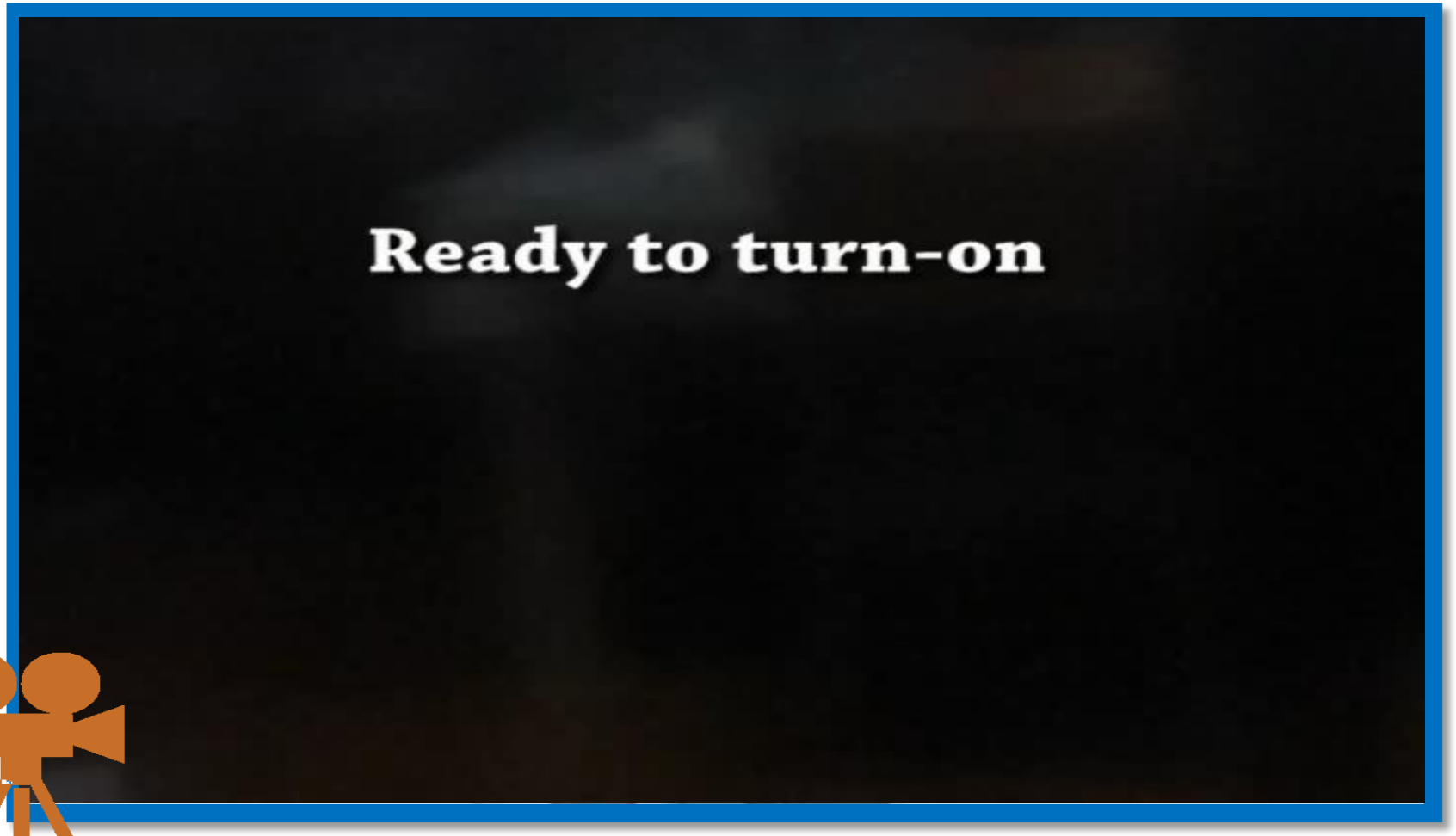
Really Satisfied with 3s Booting?



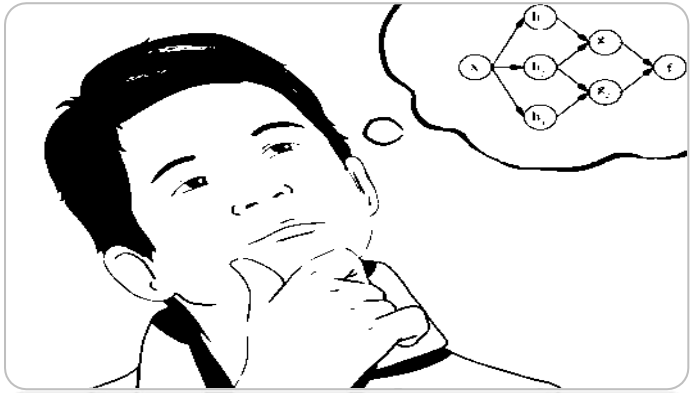
Main Takeaway

- **A lot of approaches for fast-booting in CE devices**

- **Challenged by new tackles**
  - Increasing memory capacity
  - Growing service dependencies for sophisticated applications

State-of-the-art kernel memory allocator

Hybrid Init scheme to overcome dependency complexity



At poster session tomorrow

➢ Source - http://www.mumbairock.com/profiles/blogs/this-puzzle-is-called-lateral-thinking-just-check-it-out

FAQ

1. Who cares about fast-boot of CE devices? Can you do it for all CE devices?
2. Sounds too good. Are there any limitations?
3. I totally don’t get why you are doing this.
4. Are you going to release it? Or is it a one of talk?
5. Why don’t you apply “cold boot “ techniques for smart phone?
6. How about you attach the battery into TV with suspend-to-ram?

Answer

1. There are a lot of research papers for fast-boot. But, the **existing studies are not enough to get faster booting**. We are challenged to make a novel solution to overcome this new hurdle for a big jump.

2. We still need to study in order to find **good approaches in new system environments**.

3. We focus on the **cold-boot based fast-boot techniques** for solving the complaints of customers from plug-off situation.

4. We have put our ideas into **http://opensource.samsung.com** as well as deployment of commercial devices .

5. In case of a smart phone, customers don't try to turn-on the smart phone in cold boot mode, because **they always end up charging the battery**. So, suspend-to-ram is just perfect for phone in real environment.

6. Good question. Manufacturers are already deploying **Battery-powered LED TV**. But, battery support is not suitable because lifespan of TV (7 years) is longer than the smart phone. Over all, battery component results in higher price of popular TV.