



Designer's Guide Consulting

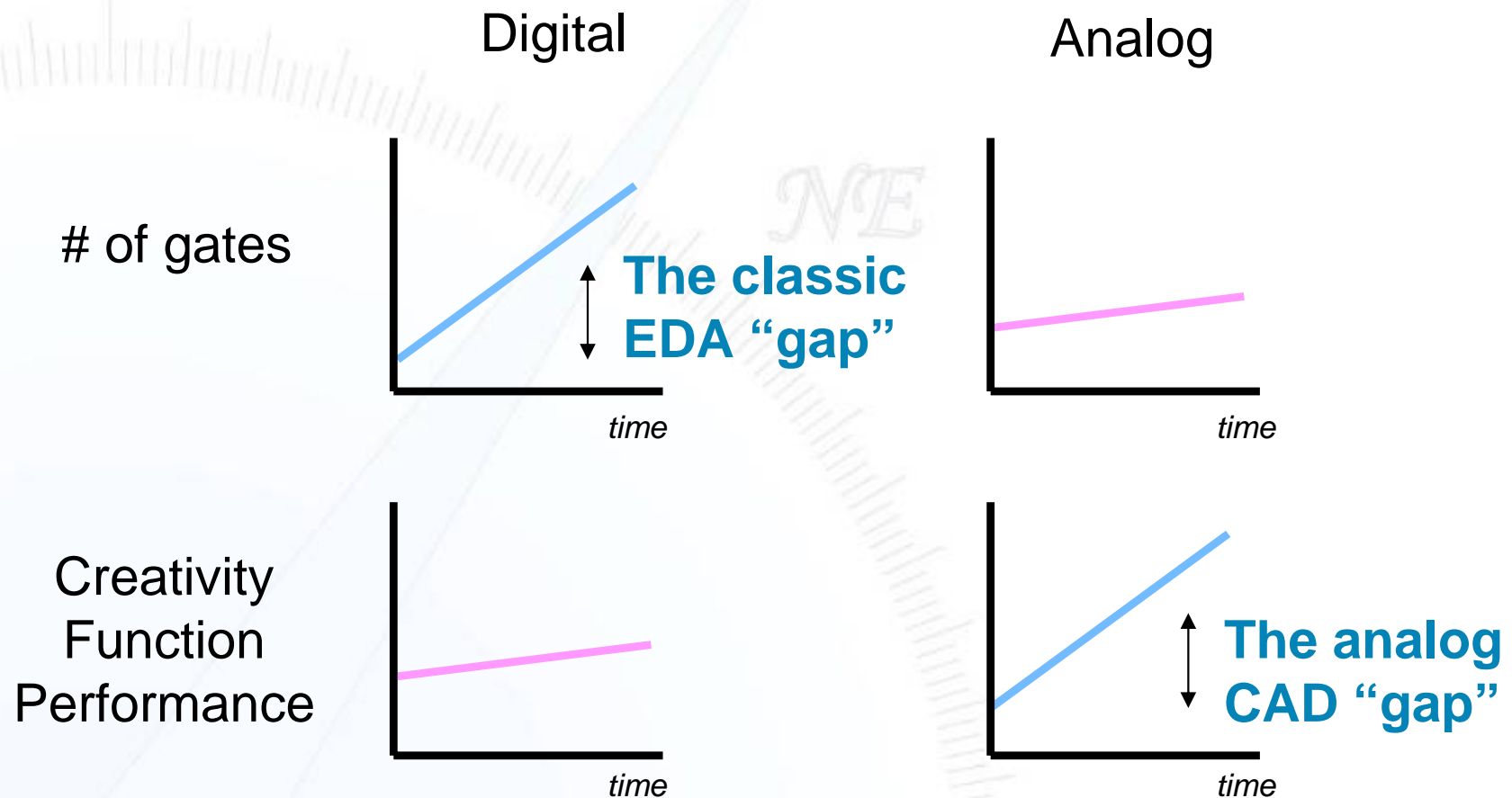
Bridging the gap between design and EDA

Trends in RF/Mixed-Signal Design and Its Implications on Computer Aided Design

by Henry Chang, Ken Kundert
9/22/05



Bridging the GAP



Outline

- Design Drivers
- Design Challenges
- Addressing Challenges
 - Design Teams
 - Methodology and CAD
- Conclusions



The Morning Paper

Fry's ELECTRONICS
HOME OF FAST, FRIENDLY, COURTEOUS SERVICE.®

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M-F 8-9, Sat 9-9, Sun 9-7
Prices Good Fri, Sept. 9, 2005 thru Tues, Sept. 13, 2005
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VISA MasterCard DISCOVER

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CAMPBELL 600 E. Hamilton Ave. (408) 364-3700 • FAX (408) 364-3718
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SEIZING SAVINGS

AMD Athlon™ PRO 3200+ PROCESSOR
INTEL READY
MEDIA PC
\$179.99

14.1" XGA TFT
SCREEN NOTEBOOK
WITH VIA C3 1.2GHz PROCESSOR
\$499.99

ViewSonic
17" TFT DISPLAY
WITH 12MS RESPONSE TIME
\$199.99

Intel® Pentium® 4 3.0GHz
PROCESSOR PC WITH HYPER-THREADING
TECHNOLOGY, DVD-RW DRIVE AND Windows® XP
WITH A 17" TFT MONITOR AND COLOR PRINTER
\$499.99

Canon
PIXMA
MP100
PRINTER
\$19.99

Color
EMC-5000
COLOR EMV-C-5000
\$19.99

52x CD-R
16x DVD-R
\$19.99

8x DVD-R
16x DVD-R
\$19.99

16x DVD-R
16x DVD-R
\$19.99

32" LCD TV
\$899.99

300GB
ULTRA-ATA HARD DRIVE
\$19.99

512MB
PC3200 DDR MEMORY
\$19.99

3.0-мегапиксель
DIGITAL CAMERA
\$19.99

McAfee
VirusScan 2006
\$19.99

MERCURYNEWS.COM

1AA

Friday's Fry's
Electronics
circular-
8 pages of the
electronics
We Make!!!

With "Cool" Mixed-Signal Chips

PROGRESSIVE SCAN DVD PLAYER



- Plays DVD, DVD+R/+RW, CD, CD-R/-RW, CD+G, VCD, SVCD, MP3

PLAYS MP3

\$24⁹⁹

#4493246

KEYCHAIN DIGITAL CAMERA



- Built in Memory
- Store up to 80 Images

\$12⁹⁹

#4220204

120GB INTERNAL HARD DRIVE for Only

~~39⁹⁹~~ **19⁹⁹**

after savings & rebates
\$109.99 - \$20 Instant Savings
- \$20 Mfr. Mail-In Rebate
- \$30 Mfr. Mail-In Rebate
#293303



LG

Digital Camera with Flash, Speakerphone and Voice-Activated Dialing
(C2000) 7300459



\$220 INSTANT SAVINGS

9⁹⁹

After Instant Savings!

Reg. Price \$229.99

Share resources with up to 4 PCs with this 4-Port Wired Router. (DI-604) 4634168



4⁹⁹

After Mail-In Rebates

Reg. Price \$49.99 - \$25 Mail-In Rebate - \$20 Mail-In Rebate = \$4.99

D-Link

54Mbps WIRELESS-G BROADBAND ROUTER



\$44⁹⁹ - 25 = \$19⁹⁹

In-Store Price Mail-In Rebate Price After Rebate

3938668

*Best Buy and CompUSA ads also

Latest and More Expensive

PLAYS MP3

DVD VIDEO



**5.4" PORTABLE DVD PLAYER
WITH CAR MOUNTING KIT**

\$79⁹⁹

LMD-2548
#4366795

brother

**HL-2040
MONOCHROME
LASER
PRINTER**



- Up to 20 ppm Black, First Page Out in Under 10 Seconds
- 250-Sheet Input Capacity; Supports a Variety of Sizes and Envelopes
- Simple Setup and Operation; 8MB Standard Memory

'149⁹⁹' - 30 = '119⁹⁹' - 30 = **\$89⁹⁹**

Regular Price	Instant Gift Rebate	In-Store Price After Instant Rebate	Mail-In Rebate	Price After All Rebates
\$149.99	\$30	\$119.99	\$30	\$89.99

#4352205 Limit 1 Per Customer

**Maximize the
speed and range
of your network**



59⁹⁹
After Mail-In Rebates

with this Smart Antenna Wireless g
MIMO Router. (DI-624M) 6960238

Reg. Price \$99.99 - \$30 Mail-In Rebate
- \$10 Mail-In Rebate = \$59.99

**Best Buy and CompUSA ads also*

New Technology Premium

600% Premium!!!!

Fry's Electronics HAS ALL THE



AirLink+

10/100Mbps PCI NETWORK CARD

Limit 2 Per Customer
#4278294

99¢

NO REBATE REQUIRED!

WORKING NEEDS!



AirLink+

REBATE REQUIRED

GIGABIT PCI NETWORK ADAPTER CARD

Limit 2 Per Customer
#3887837

\$5.99

WORKING NEEDS!



AirLink 101

GIGABIT FAST ETHERNET CARDBUS ADAPTER

Limit 2 Per Customer
#4415706

1 DAY ONLY \$7.99

REBATE REQUIRED!

800%

Could Be Worse

Software

Limit 1 Per Customer



SYSTEM MECHANIC 5.0

*Rebate Offer Does Not Refund the Sales Tax Paid by the Customer **Upgrade Rebate Requires Proof of Previous Ownership

'40 - 20 - 20 = 0*

In-Store Price **Upgrade Mail-In Rebate Price After All Rebates

PC CD-ROM #4195903

Limit 1 Per Customer



E-MAIL BACK-UP & RELOCATOR

*Rebate Offer Does Not Refund the Sales Tax Paid by the Customer

Limit 1 Per Customer






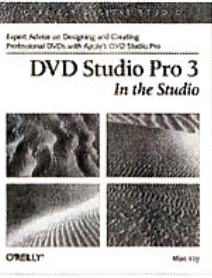
CD & DVD MAKER 7 PLATINUM

*Rebate Offer Does Not Refund the Sales Tax Paid by the Customer **Upgrade Rebate Requires Proof of Previous Ownership

Free

BOOKS

Rebate is limited to one advertised title only.
One rebate per customer, household, family, or address.
*Rebate offer does not refund the sales tax paid by the customer.

 <p>LEARNING JAVA 3RD EDITION</p> <p>'15 In-Store Price \$0* - 15 Mail-In Rebate Price After Rebate</p> <p>BOOK Limit 1 Per Customer #4464546</p>	 <p>LINUX IN A NUTSHELL 5TH EDITION</p> <p>'15 In-Store Price \$0* - 15 Mail-In Rebate Price After Rebate</p> <p>BOOK Limit 1 Per Customer #4535717</p>	 <p>QUICKBOOKS 2005 THE MISSING MANUAL</p> <p>'15 In-Store Price \$0* - 15 Mail-In Rebate Price After Rebate</p> <p>BOOK Limit 1 Per Customer #4355755</p>	 <p>DVD STUDIO PRO 3 IN THE STUDIO</p> <p>'15 In-Store Price \$0* - 15 Mail-In Rebate Price After Rebate</p> <p>BOOK Limit 1 Per Customer #4268614</p>
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Bright Spot



4' METAL POWER STRIP WITH 12 OUTLETS

MOUNTING HARDWARE INCLUDED!

\$19⁹⁹

#4214124



BUILT-IN HD

SHARP.

45" LCD HDTV

- 45" LCD TV
- Built-In HDTV Tuner
- 1920x1080 Resolution
- PC Input

SAVE '2000

\$6999

Before Savings

#4241754

Not Just Cost

DVD RECORDER



- Multiple Recording Modes, HQ, SP, LP, EP
- Continuous recording on one DVD+R/RW
- On-Screen Disc Title Navigator
- Built-In TV Tuner, Front and Rear A/V Inputs
- Editing features with Auto, Add/Del, Hide C

#4499836 Limit 1 Per Customer

1GB MP3 PLAYER

- 1GB MP3/WMA Player
- USB 2.0, FM Tuner
- 10 HR Battery Life
- Voice Recorder



PLAYS
MP3

~~\$169~~ Regular Price

~~- 70~~ Instant Gift Rebate

\$99

In-Store Price After
Instant Gift Rebate

#4543787

Functionality

Performance

Power is everything!

One Device, Do Everything



Experience  CAST

- Streaming video clips at broadband speeds
- 3D video games (Download fees apply.)
- Mobile Web at speeds faster than ever before

 CAST
Now available
in the Bay Area!

Now own the ultimate
V CAST Phone
for only **\$99⁹⁹**

Regular retail price \$149.99 less \$50 mail-in rebate. New 2-year agreement required. Shipping charges may apply.

- **V CAST capable** – Streaming video clips of the latest sports, news & entertainment
- **Built-in MP3 Player** – Listen to your favorite music on your phone
- **Bluetooth® enabled** – For hands-free wireless headset use

LG VX9300

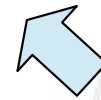
- 3D Video Games
- Streaming Video
- MP3 Player
- Bluetooth
- Mobile Web
- 1.3MP Camera
- Video Camera
- Speakerphone
- Voice Dial
- Mini SD Card
- Address Book
- Speed Dial

4 oz, 4 hour talk, 1 week standby



Fierce Competition

End Products



Selection

Prototypes



"Design In"

ICs



No margin for error!

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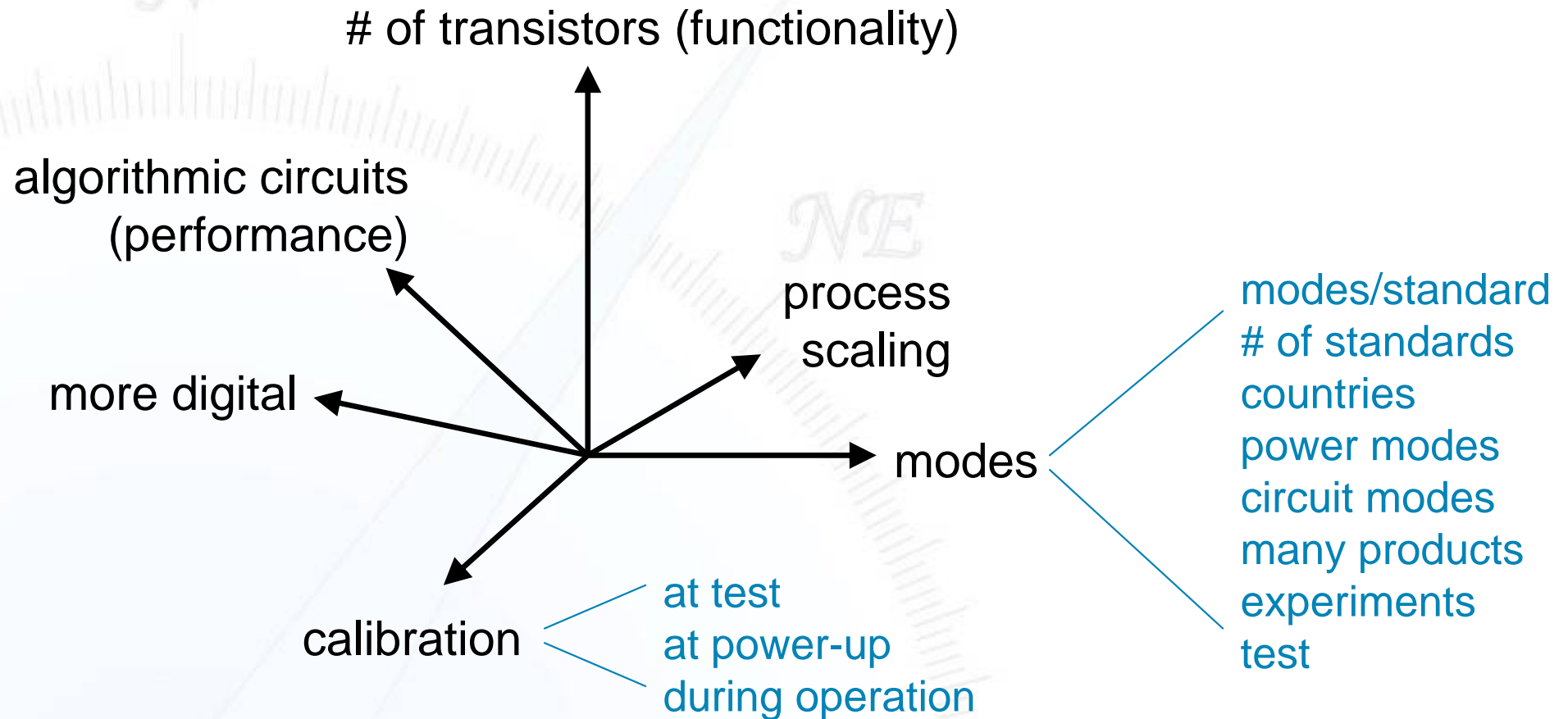


Design Challenges

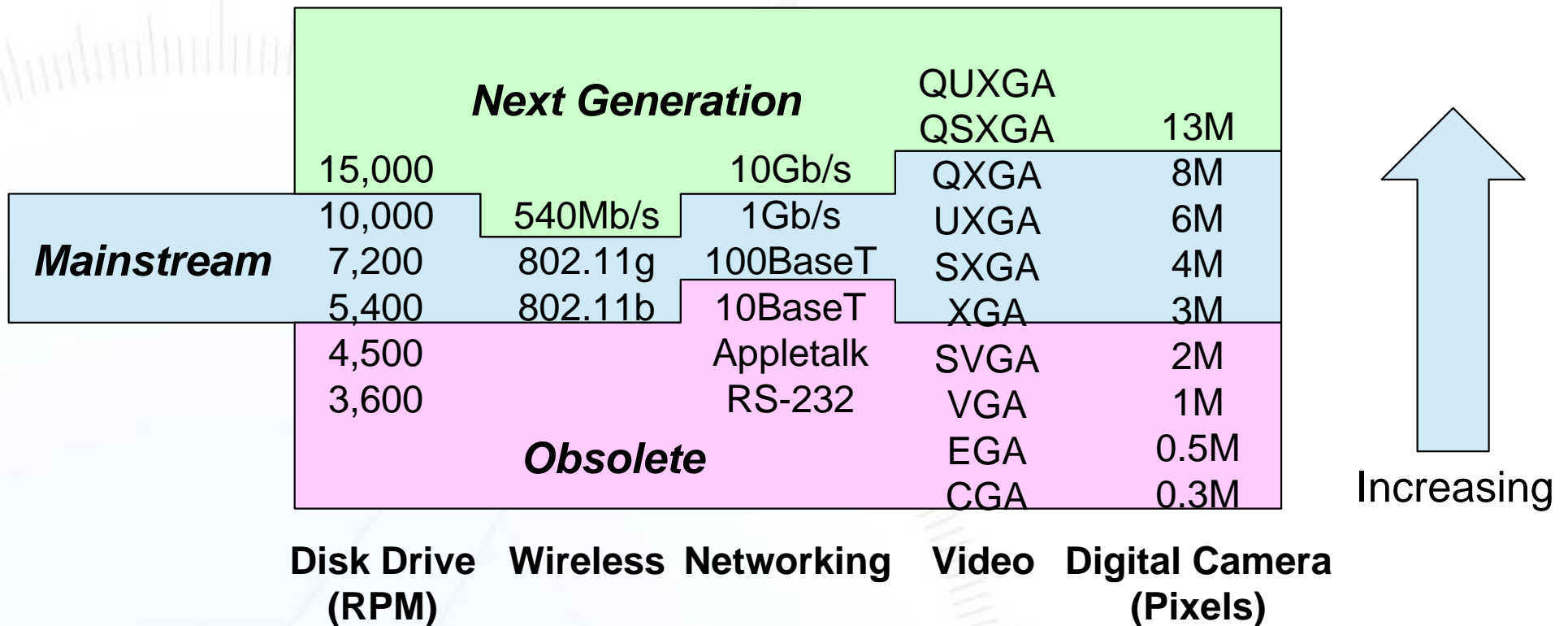
- Functionality
 - Many standards
 - Adaptable to different end products
- Performance
 - Specifications and exceeding them
 - Low power
- Cost
 - High yield
 - Small die area
- All before the holidays!
 - Design productivity
 - Design quality
 - Fast ramp to volume
- Repeatable



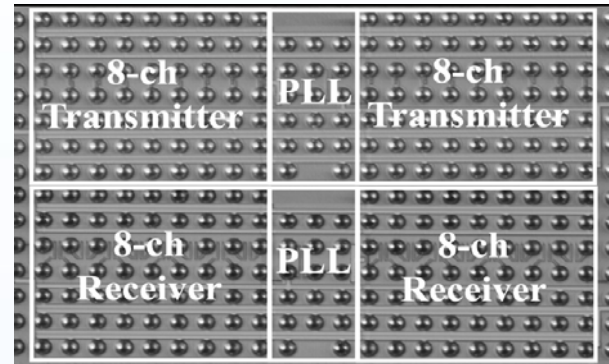
Complexity



Performance



N

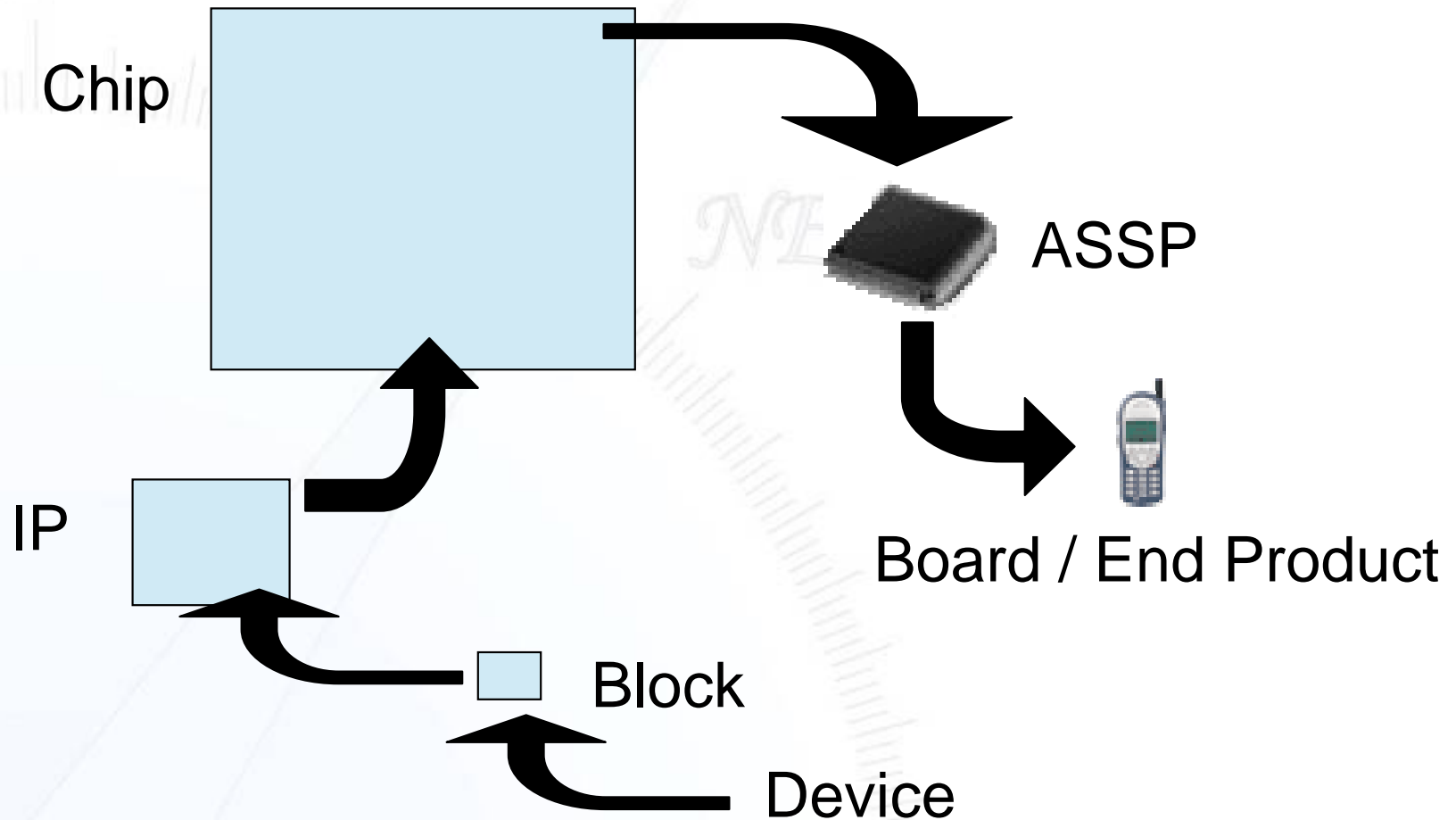


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Design Levels



Design Teams

Design Level	Designer/Team	Cause of Sleepless Nights
Analog Block	Analog Designer	Function, Performance
Analog IP	Design Lead	Architecture, Function, Performance, IP Packaging
Chip	System Designer	Architecture, Performance
	Implementation	Schedule, Integration, Function
	Verification Engineer	Function (Performance)
ASSP	Production Engineer	Design for Test, Yield
	Business Owner	Schedule, Customer Relationship
End Product	“Customer”	System “Bring Up”

Own concerns **plus** communicating with others

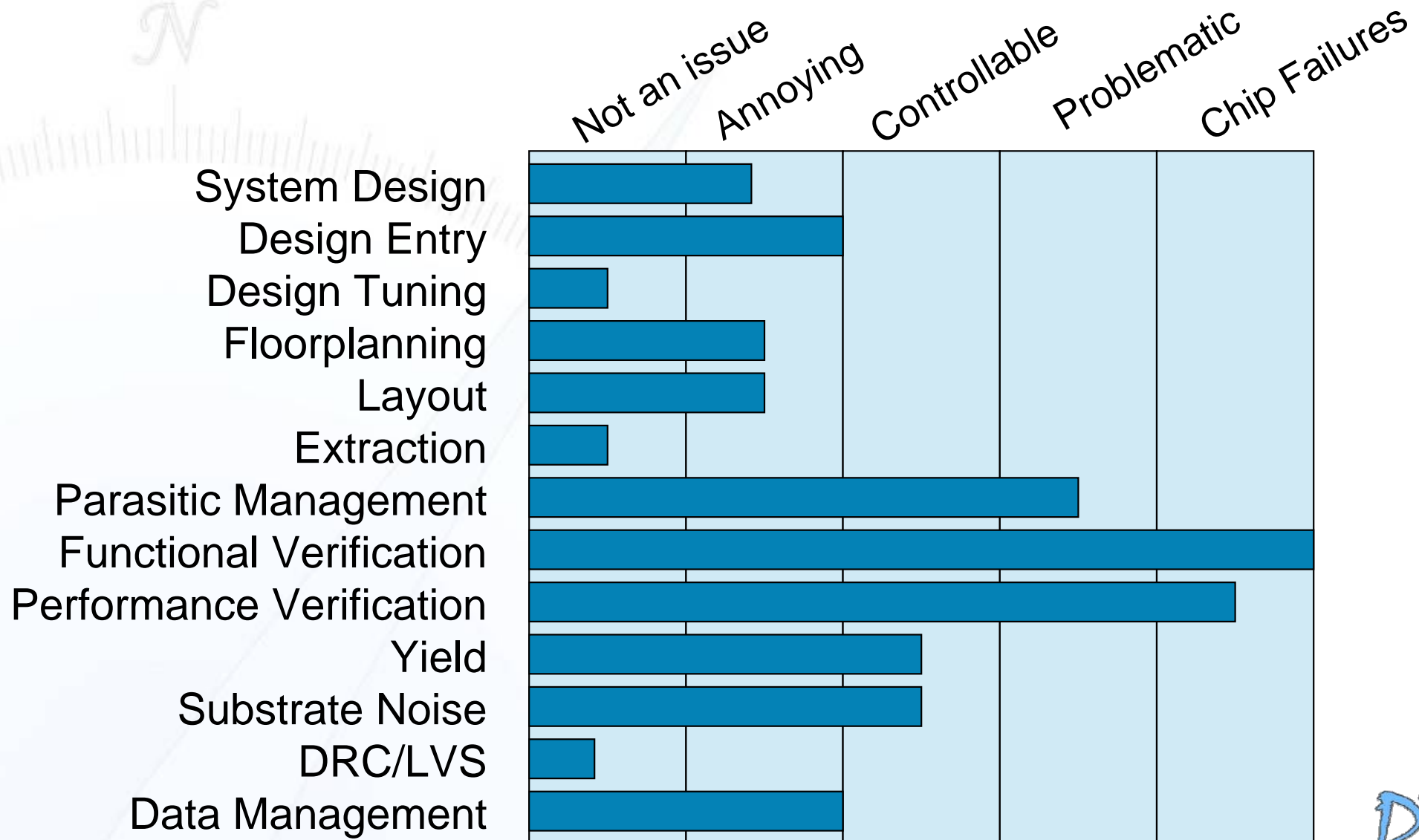


Complex Communication

- Geography / time zone / language
- Different concerns
- Different design domains
- Different design languages



The Problem



Verification Issues

- Chip Functional Verification
- IP Functional Verification
- IP Performance Verification
- Block Performance Verification



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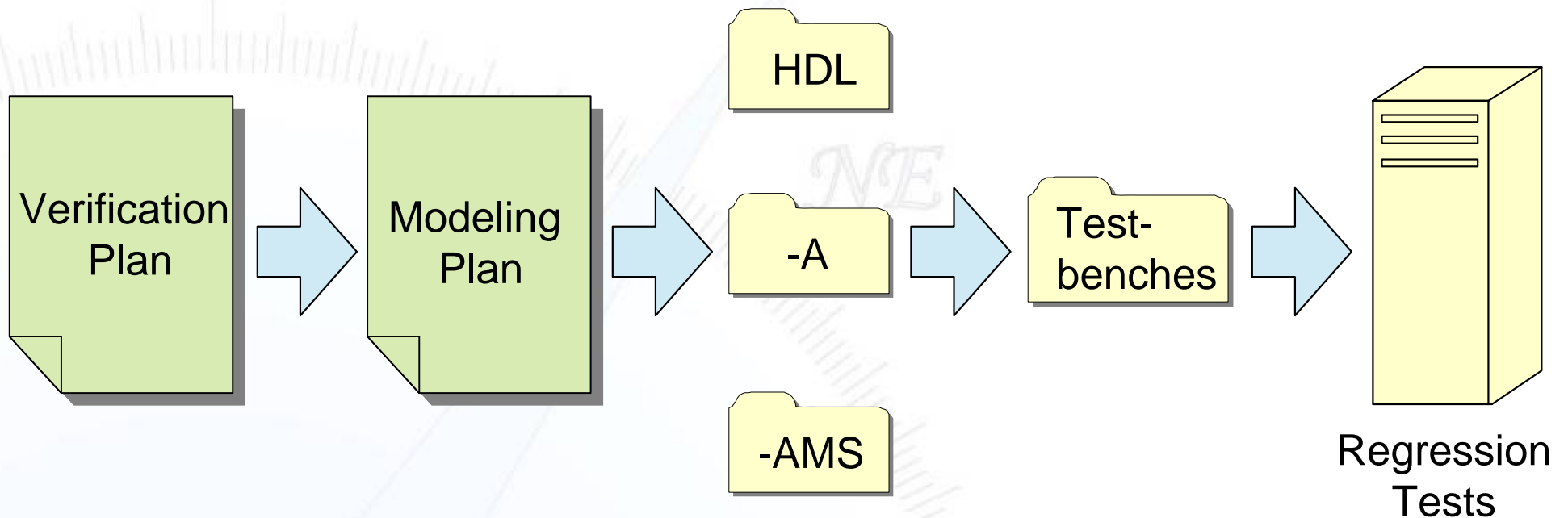


Top-Down Verification

- Verification planning
- Shared design representations
- Verification of each design change
- Continual refinement w/quick initial iteration
- Executable models and scripts used daily



Flow



Must be owned by design team and be an integral part of design process

Navigating the Details



- Verilog vs. VHDL?
- Verilog vs. Verilog-A vs. Verilog-AMS?
- When mixed-level? When mixed-mode?
- Level of model? How many levels?
- How to verify models?
- Verification vs. design models?
- Effort to invest?
- Build generic models?
- How to integrate with design?
- Who writes models?
- Purpose of each model? Concerns? What to model?
- Customer of model?
- Spice transient vs. timing simulator?
- Where does Matlab fit in?
- *How to help design not impact design?*



Design vs. Verification

Design

Scratch Pad

Excel, Matlab, Models

Parametric Selection

Verification

Full functional verification

Full performance verification

Regression Testing

Monte Carlo / Corners Analysis

Are the same models used?
Same person for both tasks?



Analog Verification Engineer

- Modeling expert (digital and analog)
- Paired with analog IP design lead
- Understands top-down verification
- Understands simulation technologies
- Focuses on verification and delivering models to customers (internal and external)



The Real Issues

- Work jointly with designers
- Talk to designers
- Test ideas with them
- Read about what they are struggling with
<http://www.designers-guide.org/>



Conclusions

- Fierce competition driving design
- Analog design is multi-dimensional
- Analog verification changing
- New methodologies required
- Analog behavioral modeling has new roles to play



Portable Music



- First AM/FM “walkman”
 - 25 years ago
 - \$285 (adjusted for inflation)
 - 4 x AA batteries
 - Stereo
- FM/MP3 Player
 - \$60
 - 1 x AAA battery
 - CD Quality
 - < 20% of the weight

Buyer's Remorse

TAKE THE MUSIC WITH YOU!

**NO REBATE
REQUIRED!**



**128MB
MP3 PLAYER**

**PLAYS
MP3**

- 128MB Built-in Memory for WMA and MP3 Playback
- PC and MAC Compatible
- LED Indicator for Play/pause Modes
- USB 2.0/1.1 Compatible

\$19.99

#4456946 Limit 1 Per Customer

References

- [1] K. Muhammad et al, "A Discrete Time Quad-band GSM/GPRS Receiver in a 90nm Digital CMOS Process," *IEEE CICC Proceedings*, September 2005.
- [2] Y. Doi et al, "A 0.8-1.3V 16-channel 2.5Gb/s High-speed Serial Transceiver in a 90nm Standard CMOS Process," *IEEE CICC Proceedings*, September 2005.
- [3] K. Gulati et al, "A Highly-Integrated CMOS Analog Baseband Transceiver with 180MSPS 13b Pipelined CMOS ADC and Dual 12b DACs," *IEEE CICC Proceedings*, September 2005.

