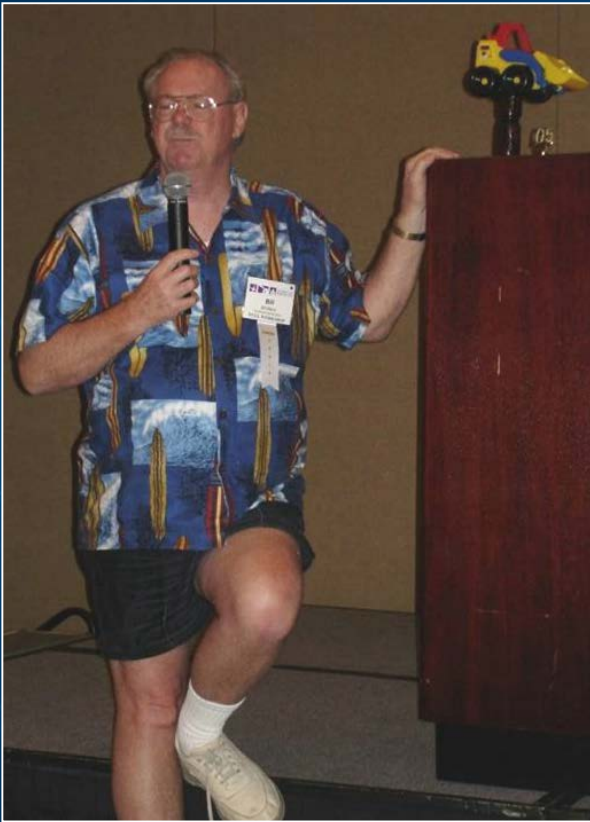# Welcome to the 25th Annual SW Test Workshop

Jerry Broz, Ph.D.

SW Test General Chair

Twenty-Five Years of Probe Technology

Many thanks to all of the 7500+ attendees from around the world !

Southwest Test Workshop

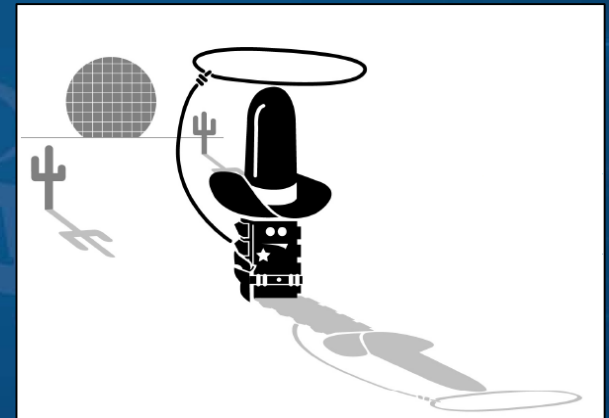**William R. Mann**
Founder of SW Test Workshop
SW Test Lifetime Achievement Recipient
Senior Member IEEE

- **1990: Bill Man (at Rockwell) organized a small user's group that focused on wafer test issues and included key suppliers.**

- **1991: Recognized the need for a dedicated forum on all aspects of microelectronic wafer probe testing that deals with "real world" problems and solutions**
  - 40 technologists attended the first "official" workshop
  - Unique "presentation only" format (i.e., no technical manuscript) and all presentations were made available in the public domain
  - Relaxed atmosphere that balanced a technical program (~50%) with open discussions, social activities, and networking (~50%)

June 7-10, 2015   25TH ANNIVERSARY 2 0 1 5   SW Test Workshop

Southwest Test Workshop

- **1992 onward: SWTW grew to become a premier wafer test and probe technology workshop.**
  - Over 400 technologists from around the world attend each year (with as many as 675 attendees)
  - Technical program with 9-sessions and 29-presentations that often include new technologies and product introductions

- **2004: SW Test "table top" EXPO was added to the workshop program**
  - SW Test EXPO focused exclusively on probe-related products and services.
  - SW Test EXPO provided even more opportunities for networking and socializing.
  - SW Test EXPO now has full-sized booth an sells out !

June 7-10, 2015   25TH ANNIVERSARY 2015   SW Test Workshop

Semiconductor Wafer Test Workshop
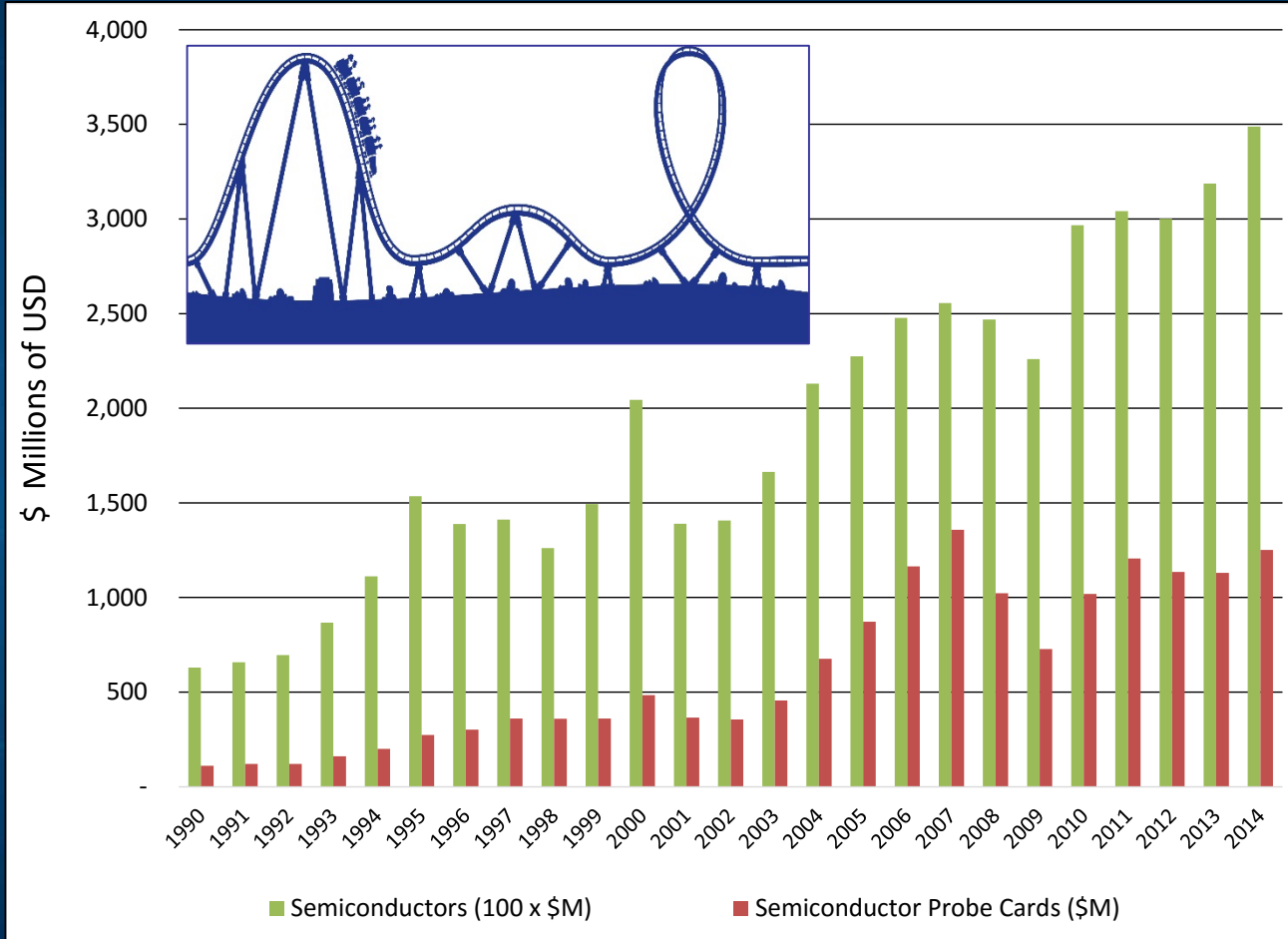## (now the SW Test Workshop)

- **2006 to present: Jerry Broz, Ph.D., becomes the General Chair of SW Test Workshop**
  - Established the William R. Mann Student Travel Grant
  - Moved away from Computer Society to CPMT
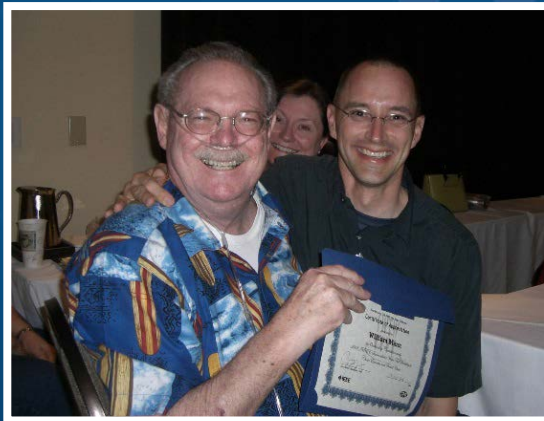
- **2010 to present: SW Test Workshop moves to RBI**
  - High quality technical content and great networking
  - International attendance with more opportunities for socializing as well as problem solving.

It's Been Quite a Ride !

IC = $348.8B
PC = $1.25B

IC = $63.9B
PC = $110M

Thanks to John West, VLSI Research

Legend: Semiconductors (100 x $M) ■ Semiconductor Probe Cards ($M) ■

Chart Y-axis: $ Millions of USD (0 to 4,000)
X-axis: 1990 through 2014

Semi Industry Overview

Top 10 Worldwide Semiconductor Sales Leaders* ($B)

Rank	1990		1995		2000		2006		2012		1Q14	
1	NEC	4.8	Intel	13.6	Intel	29.7	Intel	31.6	Intel	49.1	Intel	11.7
2	Toshiba	4.8	NEC	12.2	Toshiba	11.0	Samsung	19.7	Samsung	32.3	Samsung	8.8
3	Hitachi	3.9	Toshiba	10.6	NEC	10.9	TI	13.7	Qualcomm**	13.2	Qualcomm**	4.2
4	Intel	3.7	Hitachi	9.8	Samsung	10.6	Toshiba	10.0	TI	12.1	Micron	4.2
5	Motorola	3.0	Motorola	8.6	TI	9.6	ST	9.9	Toshiba	11.2	SK Hynix	3.5
6	Fujitsu	2.8	Samsung	8.4	Motorola	7.9	Renesas	8.2	Renesas	9.3	Toshiba	2.8
7	Mitsubishi	2.6	TI	7.9	ST	7.9	Hynix	7.4	SK Hynix	9.1	TI	2.8
8	TI	2.5	IBM	5.7	Hitachi	7.4	Freescale	6.1	ST	8.4	Broadcom**	2.0
9	Philips	1.9	Mitsubishi	5.1	Infineon	6.8	NXP	5.9	Micron	8.0	Renesas	1.9
10	Matsushita	1.8	Hyundai	4.4	Philips	6.3	NEC	5.7	Broadcom**	7.8	ST	1.8
Top 10 Total ($B)	31.8		86.3		108.1		118.2		160.5		43.6	
Semi Market ($B)	54.3		154		218.6		265.5		313.3		82.7	
Top 10 % of Total Semi	59%		56%		49%		45%		51%		53%	

Source: IC Insights   *Not including foundries   **Fabless

1st Annual SWTW 1990

Semiconductor Industry Growth since 1990 is ~7.1% per year

SW Test has seen attendance as high as 675 and as low 105 !

SW-Test Workshop

- ## SW Test is a Probe Technology Forum …
  - Focused Technical Workshop for Wafer Test Professionals
  - Practical solutions to real problems
  - Balanced mixture of semiconductor manufacturer, and supplier as well as collaborative presentations

- ## Informal Conference …
  - Friendly workshop format focused on technical exchange
  - Great social activities to facilitate networking and informal discussions
  - Meet new people, talk about probe and technology, and **have some fun !**

- ## SW Test pursues a "Green Initiative" …
  - Downloadable eProceedings and enviro-friendly practices

SW Test 2015 e-Proceedings ?

www.swtest.org

Password for Sunday = sandiego
Password for Monday = longmont

- **SW Test Team continues to be focused on a green initiative.**

- **Each day of the workshop will be available for download in a password protected file.**

  http://www.swtest.org
  WiFi Password = aragon2015

- **WiFi will be available during the entire workshop to allow access to website for download.**

- **The daily PDF file password will be announced through the day.**

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SW Test 2015 e-Proceedings ?

Attendance in 2015 is Strong !

2015
364 Registered
As of 15-May

ASIA 19%
PAC - RIM 2%
EUROPE 11%
ROW 2%
USA 66%

2014
330 Registered

ASIA 18%
PAC - RIM 5%
EUROPE 12%
ROW 2%
USA 63%
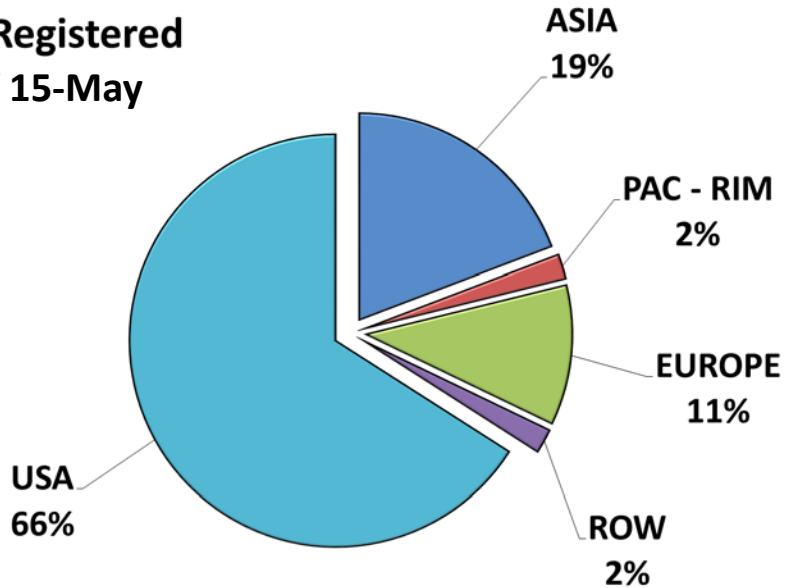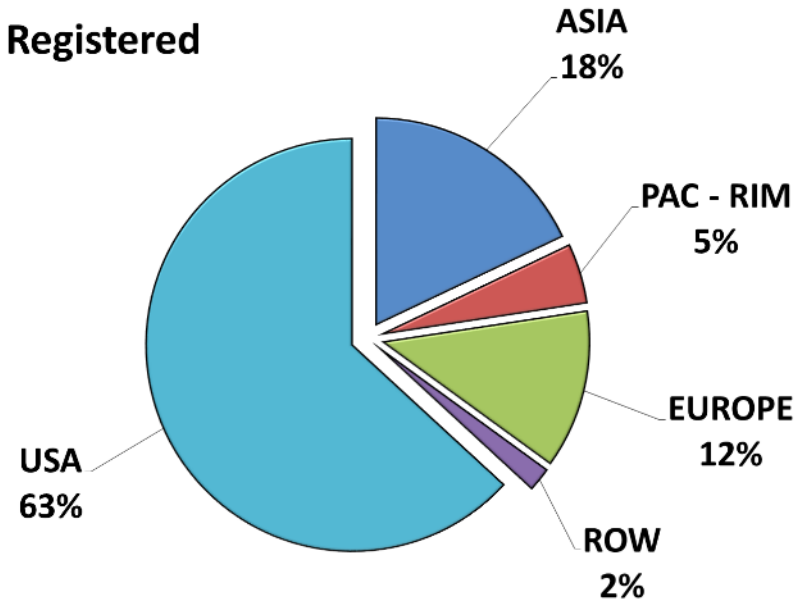
15 out of 32 Podium Presentations
have international authorship !

Projected IC Growth by Application

Semiconductor Market Forecasts

	0%	5%	10%	15%
WSTS, June		6.5% / 3.3%		
Gartner, July		7% / 5%		
Mike Cowan, Sep.			9.8% / 4.6%	
Future Horizons, Sep.			10.7% / 15%	
MIC, Sep.		6.7% / 3.1%		
IC Insights (IC), Sep.		7.1% / 7.5%		
Semiconductor Intelligence, Sep.			10% / 11%	

■ 2014 ■ 2015
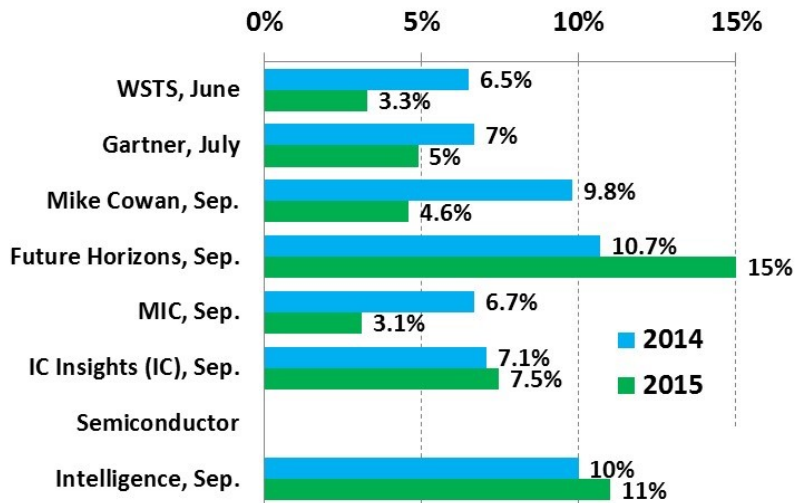
WSTS predicts
- 3.4% growth for 2015 ($344.5 billion)
- 3.1% growth for 2016 ($355.3 billion)

Automotive Tops IC Market Growth Rate
(2013-2018 CAGRs)

	0%	2%	4%	6%	8%	10%	12%
Automotive						10.8%	
Comm				6.8%			
Ind/Med				5.7%			
Total ICs				5.5%			
Gov/Mil			4.1%				
Consumer			4.1%				
Computer		3.3%					
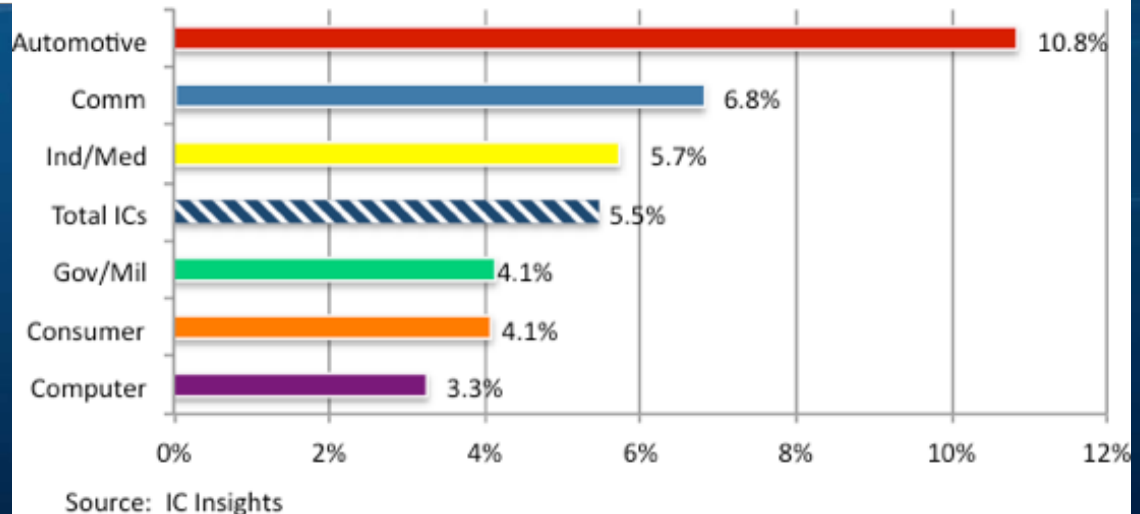
Source: IC Insights

Market Sizes and Growth Rates

IC End-Use Markets ($B) and Growth Rates

- Standard PCs $59.1
- Cellphones $70.7
- Automotive $21.7
- Tablets $17.6
- Wireless Networks $9.4
- Internet of Things* $3.3
- Servers $14.0
- Digital TVs $14.1
- Game Consoles $4.5
- Medical $4.5
- Set-Top Boxes $5.5

Y-axis: Share of 2014 IC Sales (0% to 30%)

X-axis: 2013-2018 CAGR (-1% to 23%)
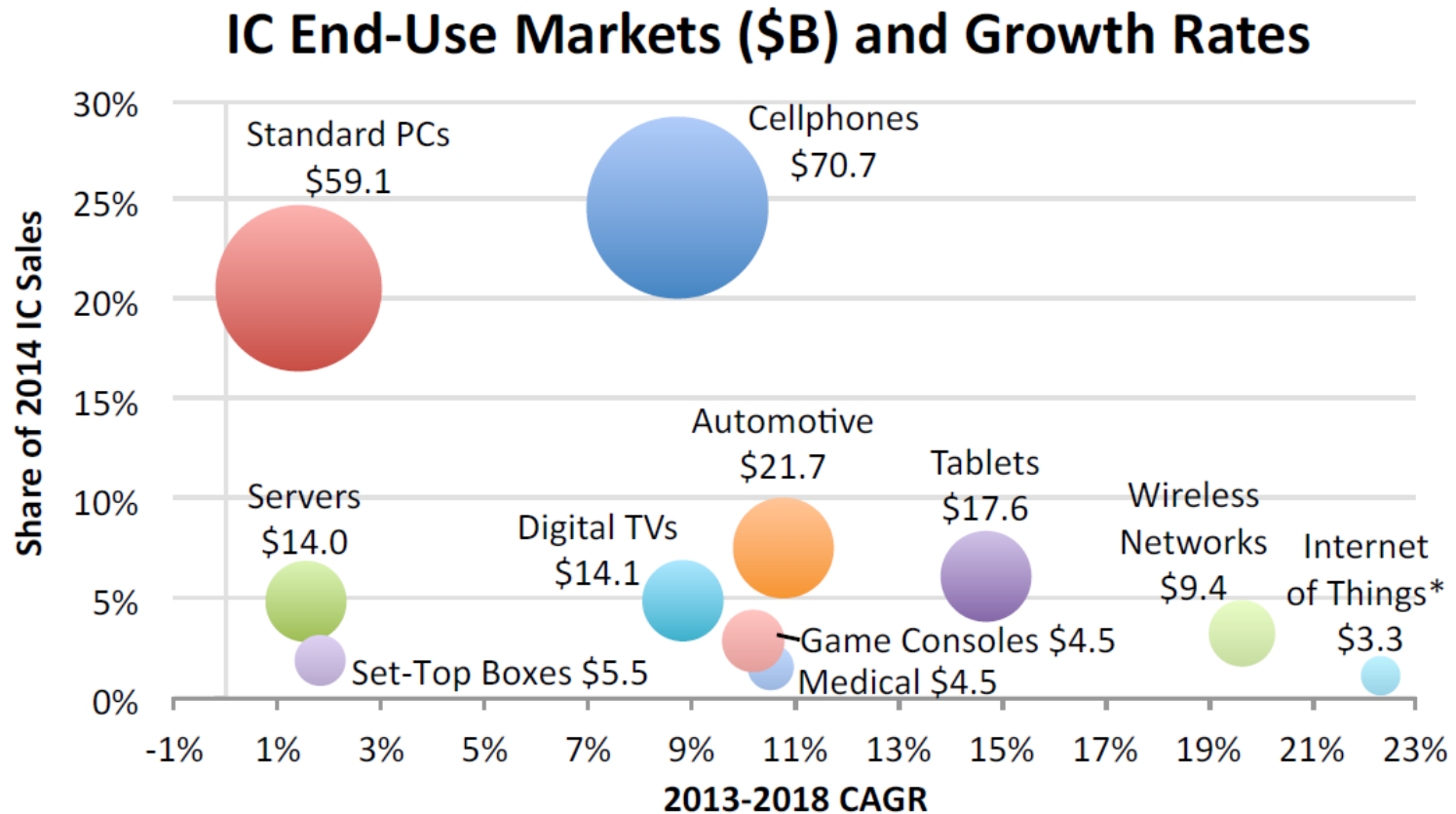
*Covers only the Internet connection portion of systems
Source: IC Insights

Market Players

Source: IDC

Source: IDC Application Forecaster, July 2014
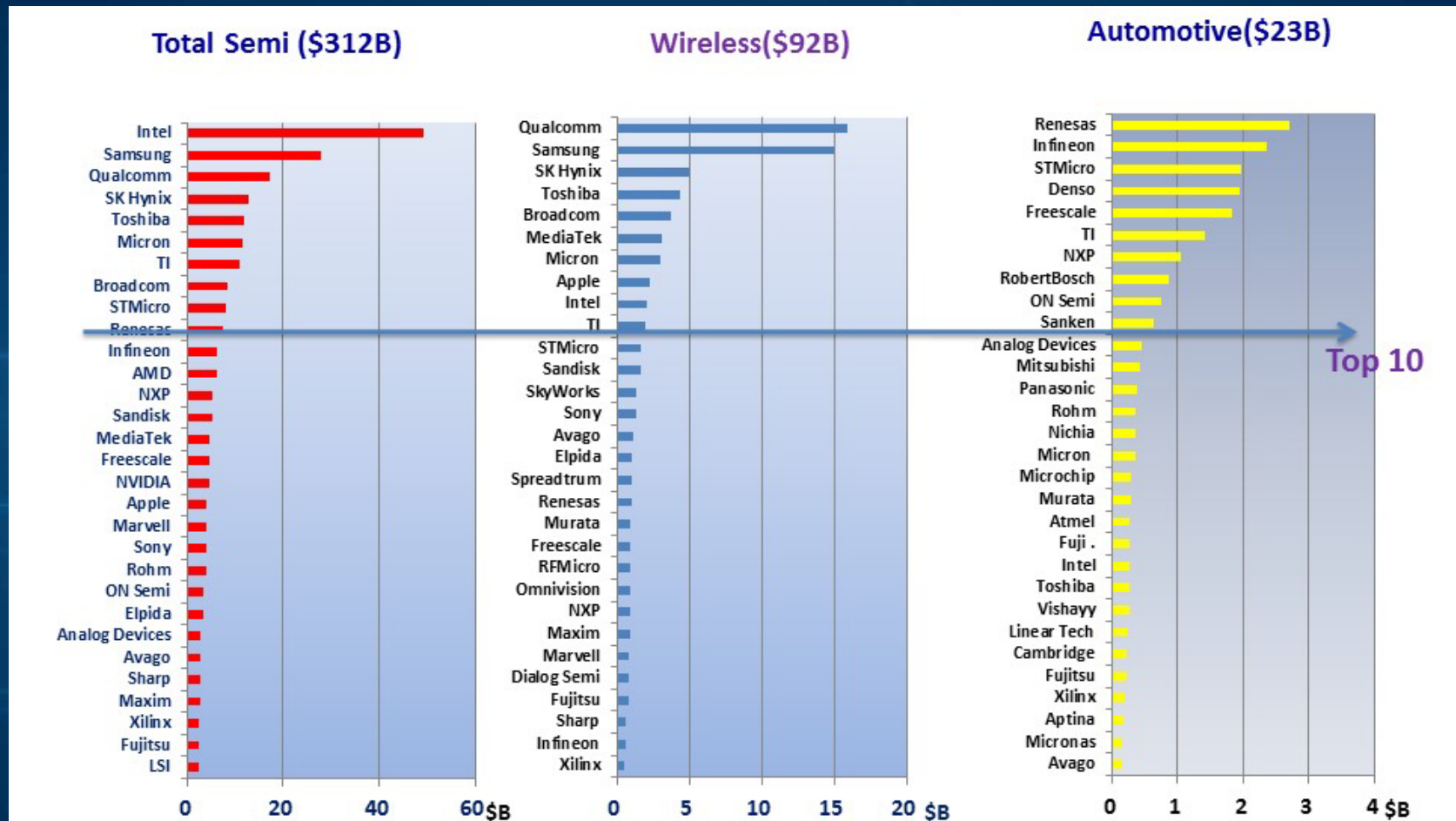
Freescale + NXP = Largest Supplier of Automotive IC
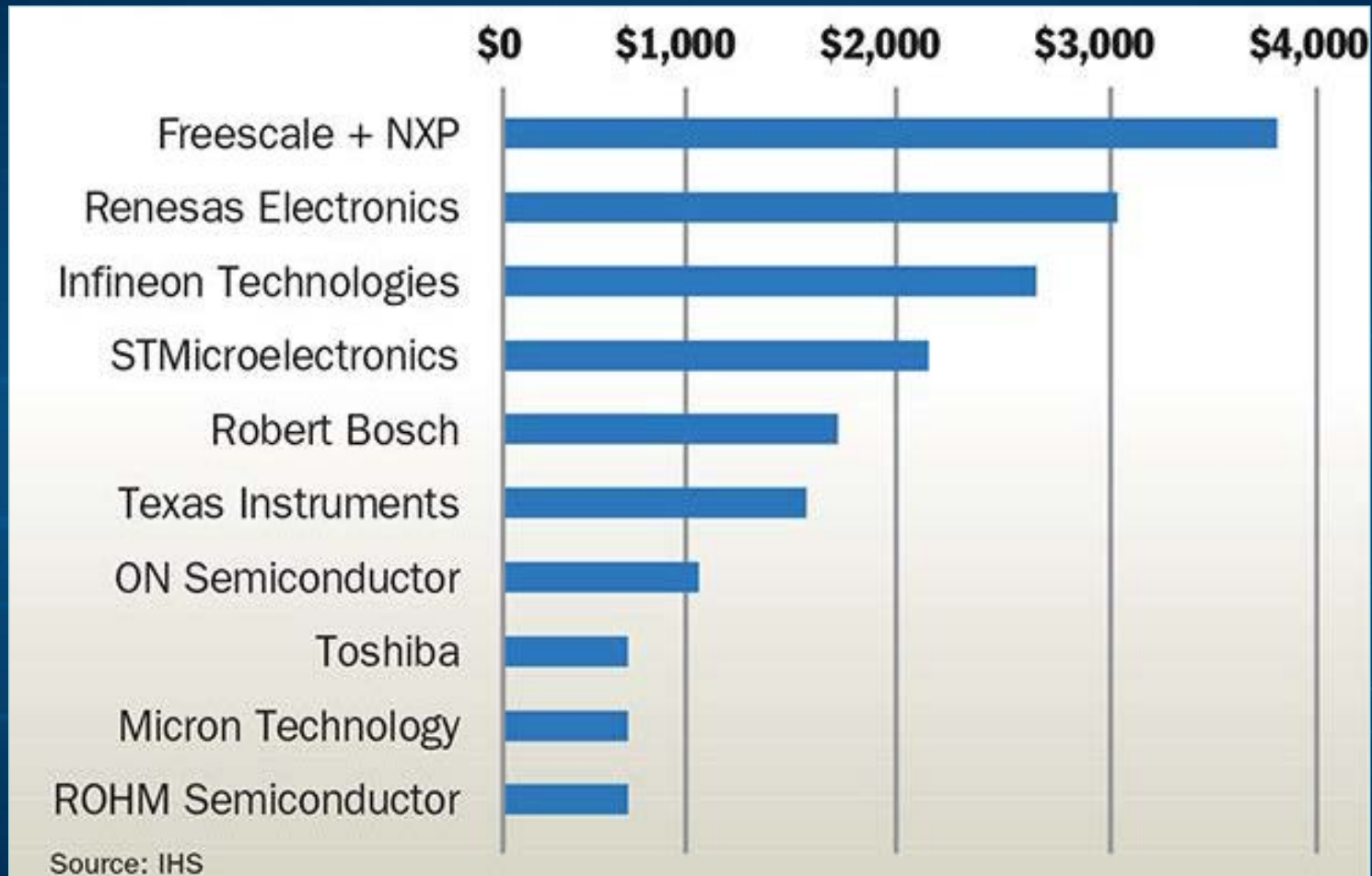
Worldwide IC

Semiconductor Fabrication

US 9.2%
Japan 20.5%
ROW 40.4%
Europe 8.5%
China 21.4%
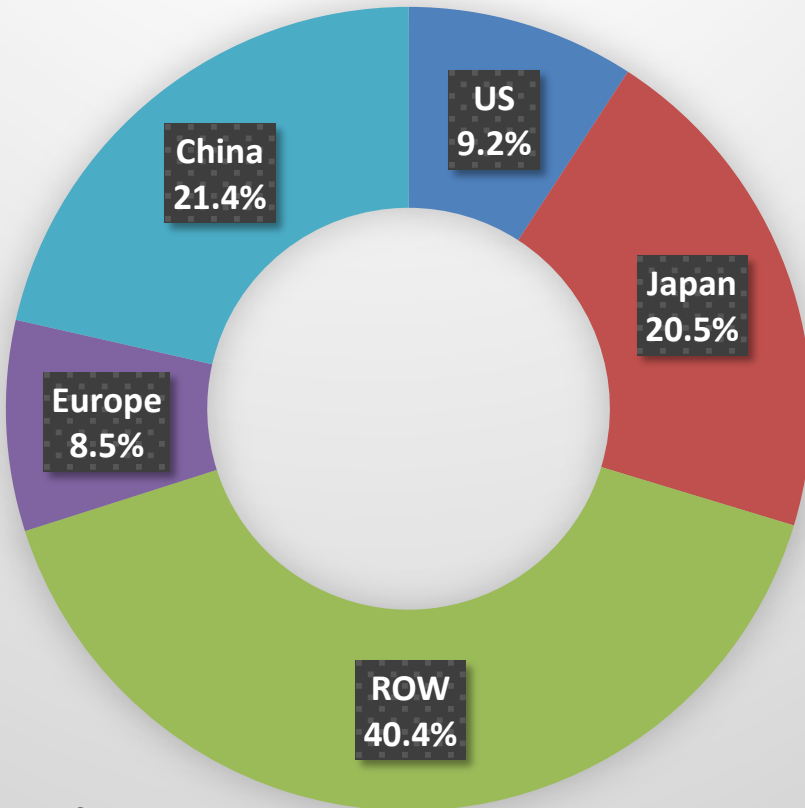
Source: SEMI.org

Semiconductor Consumption

US 11.8%
Japan 6.7%
ROW 16.2%
Europe 9.7%
China 55.6%
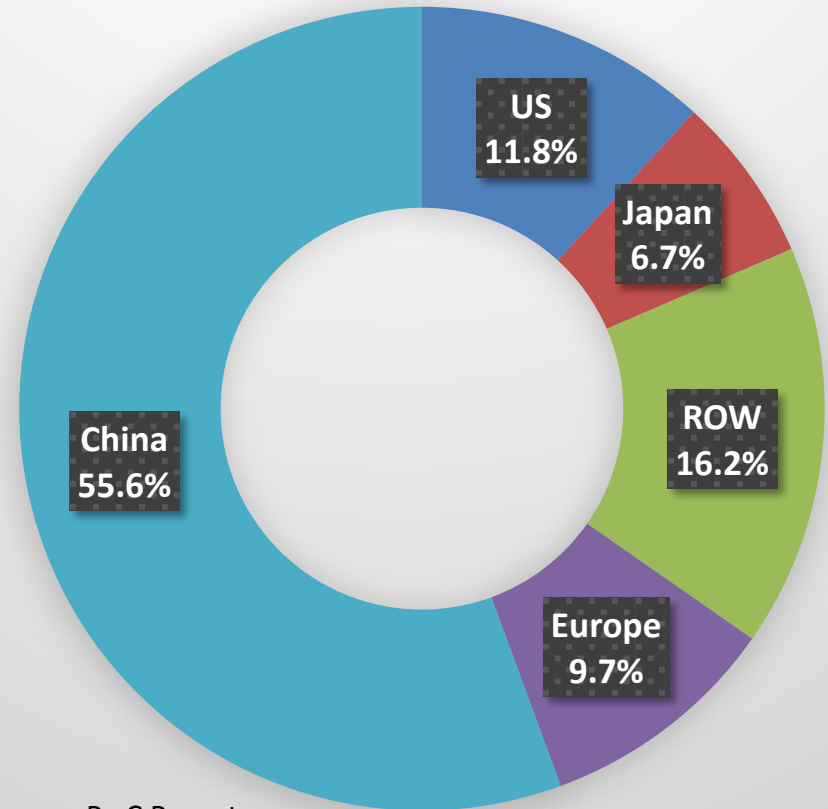
Source: PwC Report

Industry Snapshot from 1998

Rank 1998	Rank 1997	Company	Country of origin	Revenue (million $ USD)
1	1	Intel Corporation	USA	22 784
2	2	NEC Semiconductors	Japan	8 135
3	3	Motorola Semiconductors	USA	7 086
4	5	Toshiba Semiconductor	Japan	5 869
5	4	Texas Instruments	USA	5 820
6	6	Hitachi Semiconductors	Japan	4 620
7	7	Samsung Semiconductors	South Korea	4 595
8	8	Philips Semiconductors	Netherlands	4 445
9	10	STMicroelectronics (1)	France Italy	4 197
10	9	Fujitsu Semiconductors	Japan	3 826
Other Companies				-- ---
Total Revenue				134 800

Top Vendors Ranking in 1998

PC Market = $359M

1	Cerprobe
2	Japan Micronics Corp. (MJC)
3	JEM: Japan Electonic Materials
4	Tokyo Cathode Laboratories Inc
5	Wentworth Laboratories
6	FormFactor
7	Probe Technology
8	Cascade Microtech
9	ESJ
10	Upsys
11	Microprobe
12	SV Probe, Inc
13	Tokyo Electron Limited (TEL)
14	Hugle Electronics
15	UPC

Thanks to John West, VLSI Research

Industry Snapshot for 2014

1Q15 Top 20 Semiconductor Sales Leaders
($M, Including Foundries)

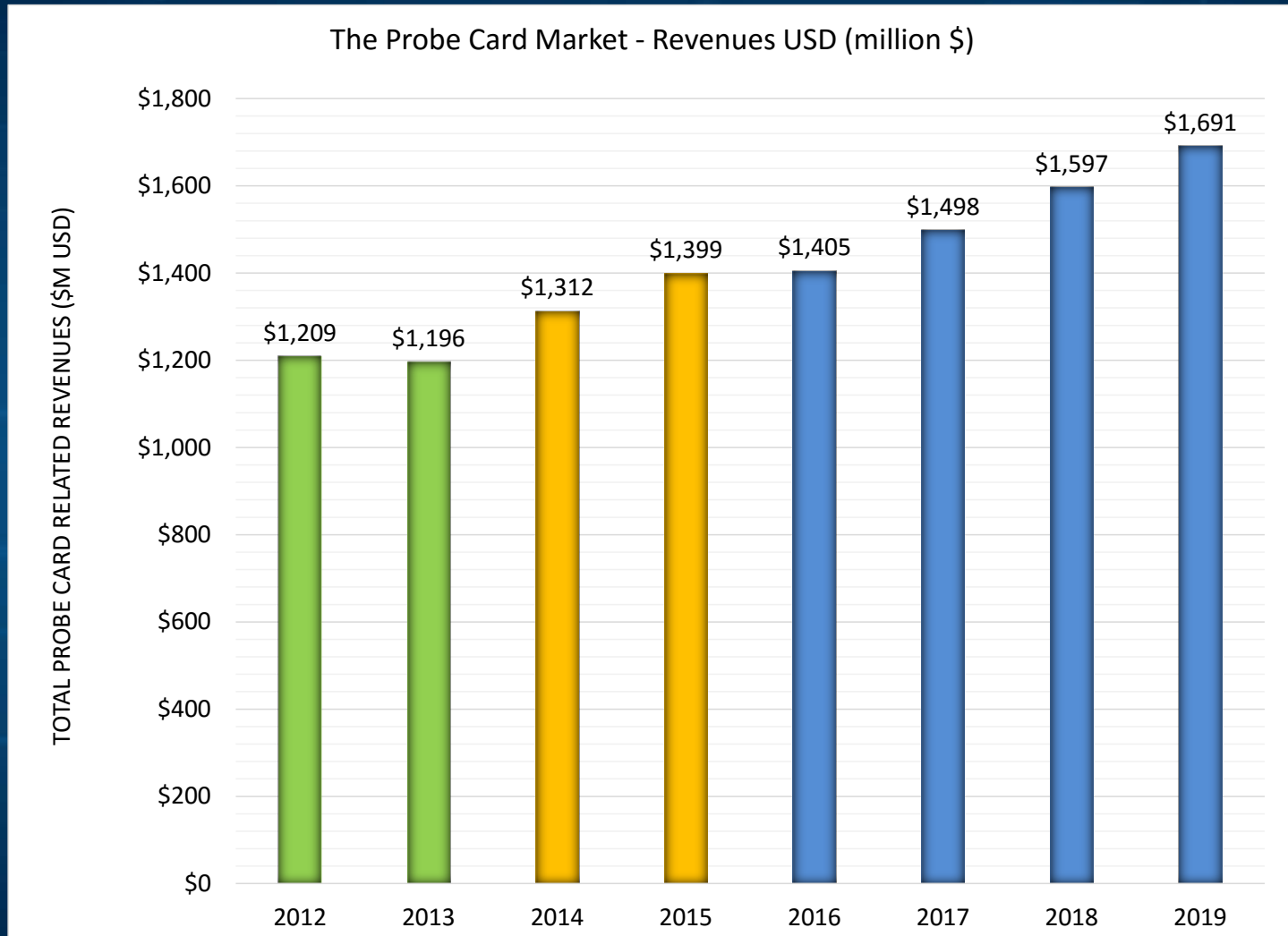| 1Q15 Rank	2014 Rank	Company	Headquarters	2014 Tot Semi	1Q14 Tot Semi	1Q15 Tot Semi	1Q15/1Q14 % Change
1	1	Intel	U.S.	51,400	11,666	11,632	0%
2	2	Samsung	South Korea	37,810	8,797	9,336	6%
3	3	TSMC*	Taiwan	24,976	4,852	6,995	44%
4	4	Qualcomm**	U.S.	19,291	4,243	4,434	5%
5	6	SK Hynix	South Korea	16,286	3,507	4,380	25%
6	5	Micron	U.S.	16,720	4,017	4,070	1%
7	7	TI	U.S.	12,167	2,791	2,939	5%
8	8	Toshiba	Japan	11,040	2,793	2,750	-2%
9	9	Broadcom**	U.S.	8,428	1,984	2,058	4%
10	12	MediaTek**	Taiwan	7,032	1,608	1,799	12%
11	10	ST	Europe	7,384	1,820	1,700	-7%
12	13	Infineon	Europe	5,938	1,440	1,672	16%
13	15	Avago**	Singapore	5,644	1,305	1,615	24%
14	11	Renesas	Japan	7,307	1,865	1,470	-21%
15	14	NXP	Europe	5,647	1,246	1,467	18%
16	17	Sony	Japan	5,292	1,011	1,272	26%
17	20	GlobalFoundries*	U.S.	4,355	980	1,190	21%
18	18	Freescale	U.S.	4,548	1,093	1,169	7%
19	23	Sharp	Japan	3,515	700	1,137	62%
20	21	UMC*	Taiwan	4,350	1,006	1,133	13%
—	—	Top 20 Total	—	259,130	58,724	64,218	9%

*Foundry   **Fabless   ***6% growth excluding the foundries

Source: Company reports, IC Insights' *Strategic Reviews* database

Probe Card Revenues

The Probe Card Market - Revenues USD (million $)

Thanks to John West and Risto Puhakka!

Revenue by Technology
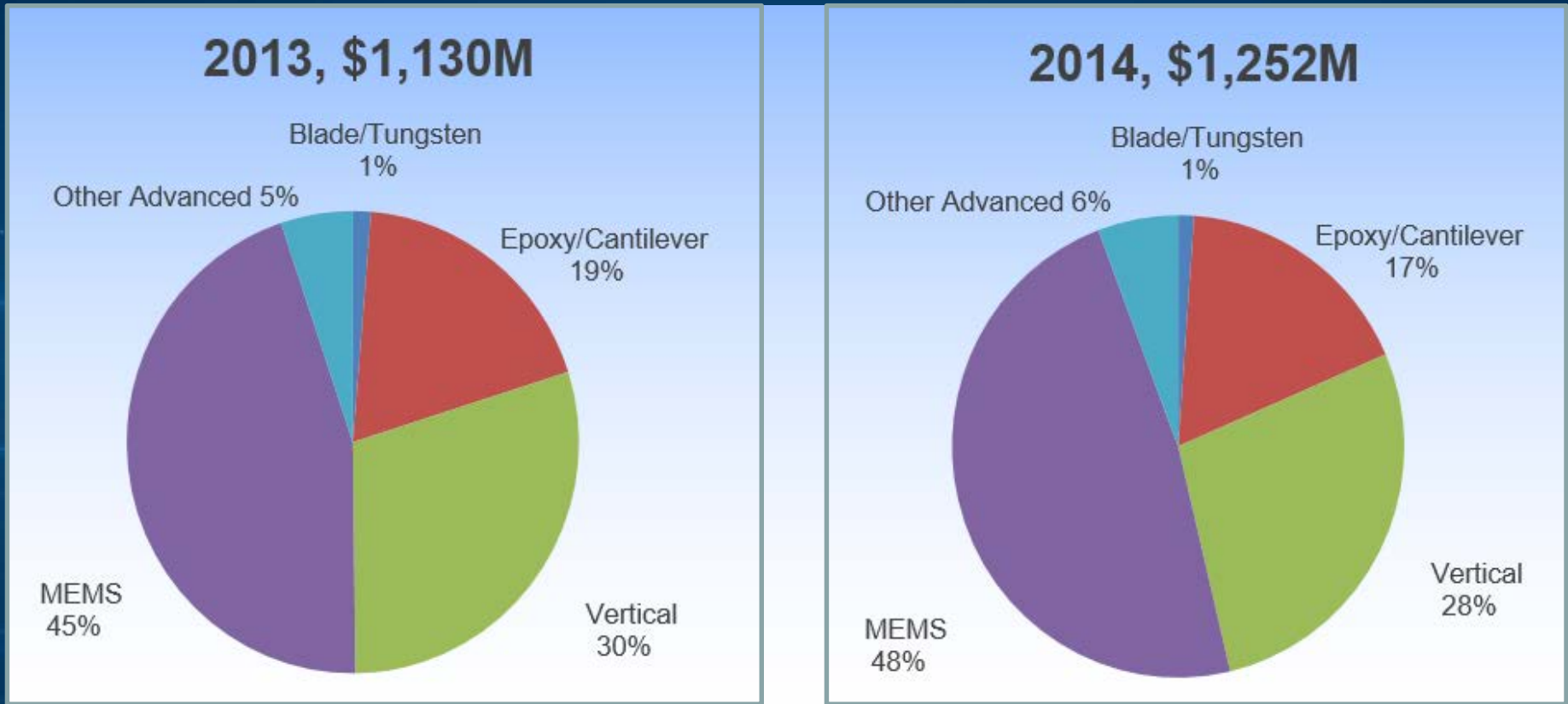
2013, $1,130M

- Blade/Tungsten 1%
- Other Advanced 5%
- Epoxy/Cantilever 19%
- Vertical 30%
- MEMS 45%

2014, $1,252M

- Blade/Tungsten 1%
- Other Advanced 6%
- Epoxy/Cantilever 17%
- Vertical 28%
- MEMS 48%

Thanks to John West and Risto Puhakka!

June 7-10, 2015   25TH ANNIVERSARY 2-0-1-5   SW Test Workshop

Top Probe Card Vendors

Top 10 Semiconductor Probe Card Vendors 2014
Revenues in $M, Calendar Year (excludes service and spares)

Rank 2014	Rank 2013	Company	2013	2014	% Change
1	(1)	FormFactor, Inc.	232	269	16%
2	(2)	Micronics Japan Co., Ltd.	195	220	13%
3	(3)	Technoprobe	100	105	5%
4	(4)	Japan Electronic Materials	82	95	16%
5	(5)	MPI Corporation	64	83	30%
6	(9)	Korea Instrument (KI)	37	56	51%
7	(8)	Cascade Microtech	41	52	27%
8	(7)	Microfriend	45	51	13%
9	(10)	SV TCL	33	43	30%
10	(6)	Will Technology	47	36	-23%
		Other	253.9	241.7	-5%
		Semiconductor Probe Cards	1129.9	1251.7	11%

Thanks to John West and Risto Puhakka!

25th Annual SW Test Workshop

- **Technical Program for 2015**
  - Technical Tutorial on Sunday
  - Nine Focused Technical Sessions across three days
  - 32 Podium Presentations and a Panel Discussion

- **Products / Services EXPO**
  - 42 full size booths … SOLD OUT !
  - EXPO does not compete with Technical Program

- **Corporate Support Program … MANY THANKS !**

Platinum Supporters
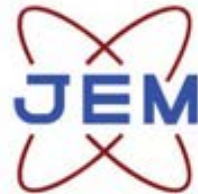
Gold and Silver Supporters

"We're not in it for the money …"

- **SW Test Team has worked closely with the RBI staff such that every attendee has free parking, in-room internet, no resort fees, WiFi access during the workshop, and the best on-site conference room rate.**

- **SW Test Executive Team …**
    - Jerry Broz, Ph.D., General Chair and Sr. Member IEEE
    - Rey Rincon, Freescale Semiconductor, Technical Program Chair
    - Maddie Harwood, CEM Inc., Finance Chair
    - Meredith Griffith, CEM Inc., EXPO / Registration Coordinator

"Who's Really to Blame …"

- **Program Committee …**
  - John Caldwell (Micron Technology)
  - Darren James (Rudolph Technologies)
  - Gary Maier (IBM)
  - Patrick Mui (JEM America)

- **Steering Committee …**
  - Gunther Boehm (FeinMetall GmbH)
  - Michael Huebner, Ph.D. (FormFactor)
  - Amy Leong (Formfactor)
  - Clark Liu (PTI)
  - Mark Ojeda (Spansion)
  - Fred Taber (Taber Consulting)
  - Joey Wu (MPI)
  - Karen Armendariz (Celadon Systems)
  - Stevan Hunter, Ph.D. (ON Semi / BYU Idaho)
  - Al Wegleitner (Texas Instruments)

> SW Test is organized, coordinated, and executed through the efforts of your colleagues.

- **New Member …**
  - Sang Kyu (SK) Yoo (Samsung Electronics – Korea)

Technical Program / Agenda

- **Sunday, June 8**
  - Tutorial Sessions
    - **Understanding RF measurements using advanced cantilever technologies**
      - Paul O'Neil MSc MIET (aps Solutions GmbH)
    - **Reduce wafer test with 3% to 10%+ by optimizing touchdown patterns**
      - André Stoelwinder (OrangGO)

  - Registration and Cocktails
  - Buffet Dinner and Keynote Presentation

Keynote Speaker

- **Sunday, June 8**

David McCann

Vice President of Packaging
R+D and Operations

The trends, challenges, and directions for silicon beyond 28nm

Technical Program / Agenda

- **Monday, June 8**
  - Registration and Breakfast
  - Vertically Challenged
  - Lasers and Sensors
    - Lunch (Aragon Lawn)
  - High Speed Testing - Challenges and Innovations
  - Technical Panel Discussions
  - SW Test EXPO 2015 w/ Dinner at Reception Stations
    - Networking at La-Taberna Bar
    - Hospitality Suites for even more networking

Rancho Bernardo 2015

You Are Here !

SW Test 2016
June 5 to 8, 2016
Rancho Bernardo Inn
San Diego, CA

June 7-10, 2015   25TH ANNIVERSARY 2015   SW Test Workshop
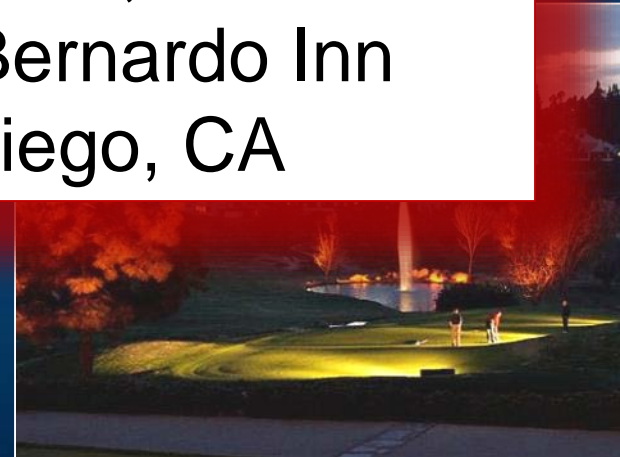
Map of the Area

SW Test EXPO 2015

- **AEHR TEST SYSTEMS**
- **Ardent Concepts**
- **Cascade Microtech, Inc.**
- **Celadon Systems**
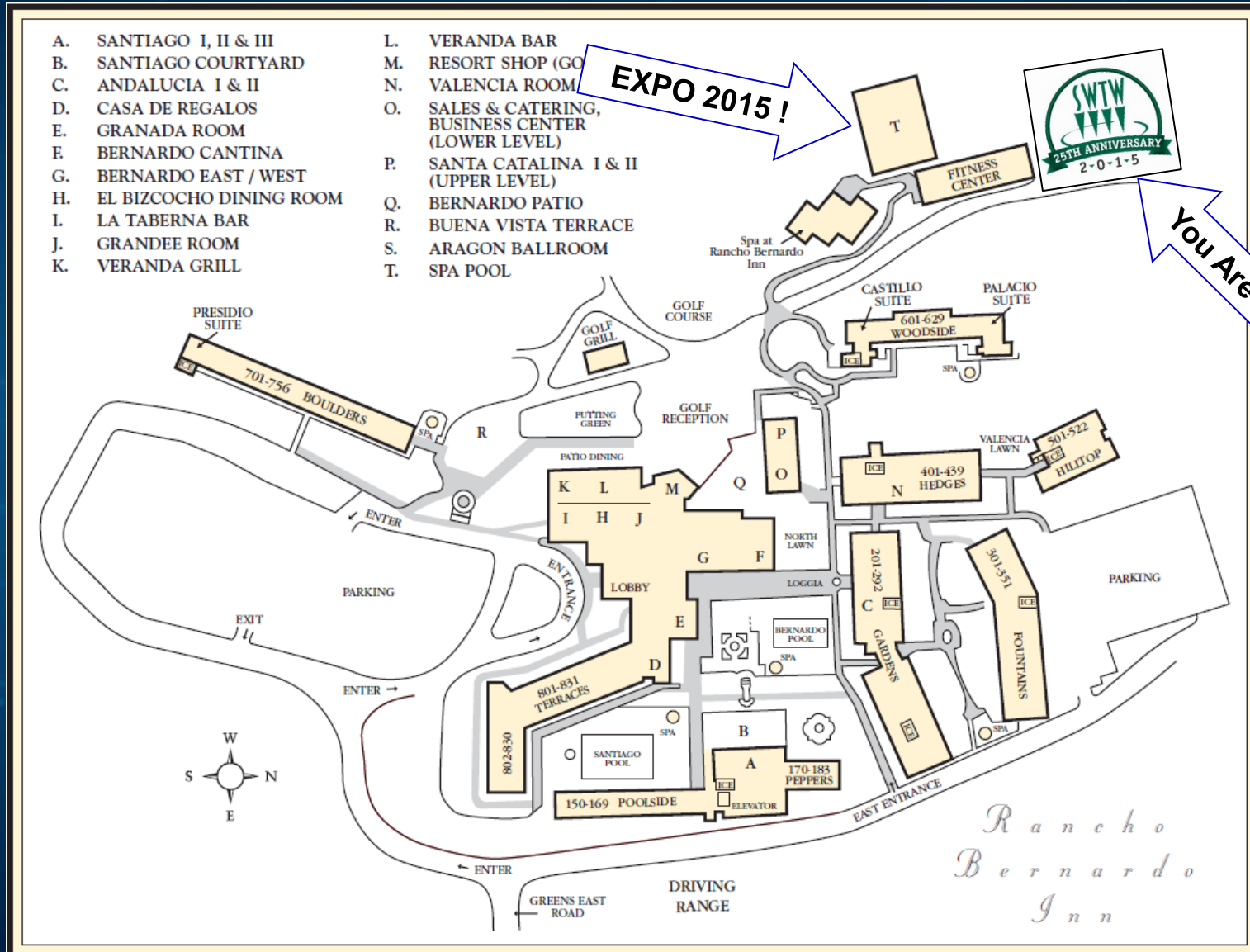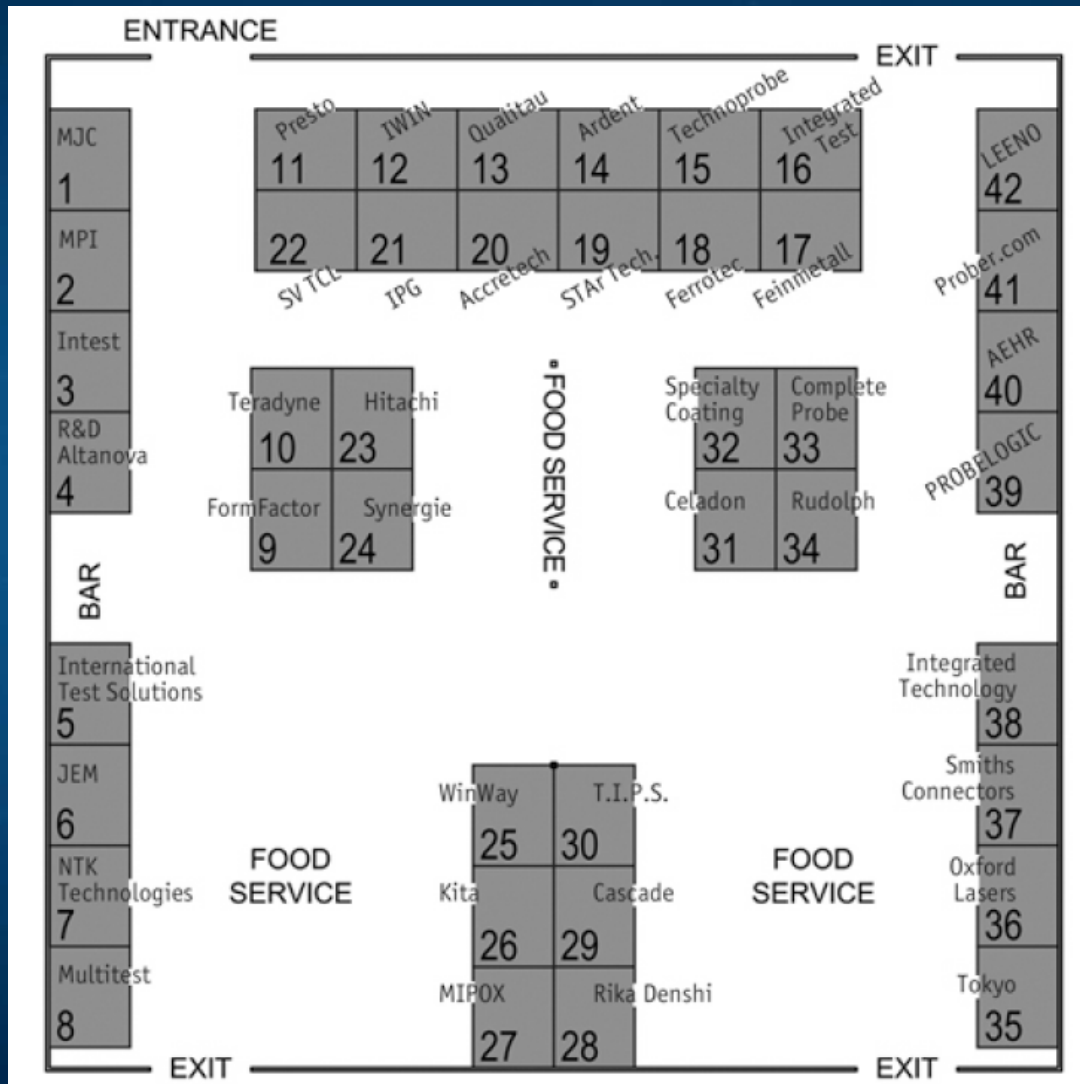- **Complete Probe Solutions Inc.**
- **Feinmetal GmbH**
- **Ferrotec (USA) Corp.**
- **FormFactor, Inc. … PLATINUM**
- **Hitachi Chemical Co, Ltd.**
- **Integrated Technology Corporation**
- **Integrated Test Corporation … SILVER**
- **International Test Solutions, Inc … PLATINUM**
- **Intest Corporation**
- **IPG Photonics, Microsystems Division**
- **IWIN Co.,Ltd.**
- **JEM America Corp. … PLATINUM**
- **Kita USA Inc**
- **LEENO Industrial Inc.**
- **MIPOX International Corporation**
- **Micronics Japan Co., LTD. … PLATINUM**
- **MPI Corporation … PLATINUM**

- **NTK Technologies**
- **Oxford Lasers**
- **Presto Engineering**
- **PROBELOGIC, INC.**
- **Prober.com**
- **QualiTau Inc.**
- **R & D Altanova … PLATINUM**
- **Rika Denshi America, Inc.**
- **Rudolph Technologies**
- **Smiths Connectors**
- **Specialty Coating Systems**
- **STAr Technologies, Inc.**
- **SV TCL - SV Probe … GOLD**
- **Synergie CAD Probe … GOLD**
- **T.I.P.S. Messtechnik GmbH … GOLD**
- **TechnoProbe America … GOLD**
- **Teradyne GSO … PLATINUM**
- **Teradyne**
- **Tokyo Electron Laboratory**
- **WinWay Technology … PLATINUM**
- **Xcerra … SILVER**

June 7-10, 2015   25TH ANNIVERSARY 2-0-1-5   SW Test Workshop

SW Test EXPO 2015

June 7-10, 2015   25TH ANNIVERSARY 2·0·1·5   SW Test Workshop

QR Code on Badges

- **QR codes on the backside of the badges**
  - First and Last Name
  - Organization
  - Email Address

- **Suggested Free Readers**
  - QRReader (TapMedia)
  - ScanLife (Scanbuy)
  - Many more free Apps are available

- **Download App and Test before entering the EXPO**

Technical Program / Agenda

- **Tuesday, June 9**
  - Registration and Continental Breakfast
  - Probe Card Analytics
  - Probe Potpourri
    - Lunch (Aragon Lawn)
  - Here is Something Different
  - EXPO 2015 w/ Refreshments will be served
  - Hawaiian Feast and Islanders Luau Show

Tuesday Social Celebrates 25th Anniversary of SW Test

- **6:00 PM – Welcome greeting by hula dancers around the RBI Spa Pool**
- **6:45 PM – Conch shell call and drums signal dinner on the Golf Course. Cash Bar available throughout the evening**
- **8:15 PM – Islanders Luau Show**
- **Kids under 12 can join for free !**

Technical Program / Agenda

- **Wednesday, June 10**
  - Registration
  - Probe Efficiency Improvements
  - High Volume Probe Challenges
  - Awards and Adjournment
  - Box Lunch (Aragon Lawn)

Recognition & Awards

- **Most "Inspirational" Presentation**
- **Best Presentation, Tutorial in Nature**
- **Best Data Presented**
- **Best Overall Presentation**

- **Some other "Special Awards"**

SWTW-2014 Awards

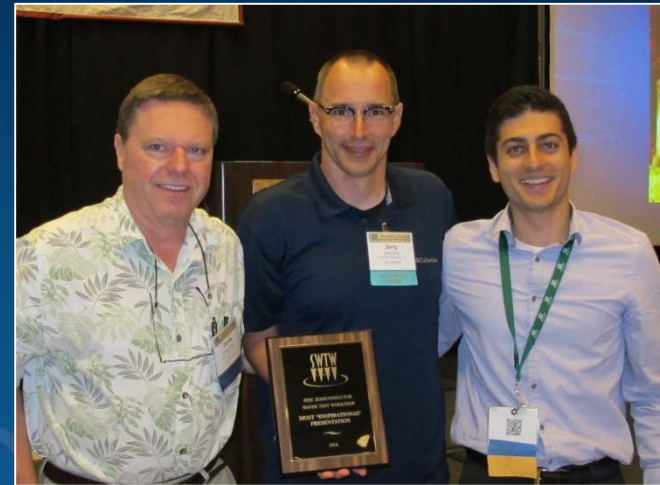## Most Inspirational Presentation

"Transferable Fine-Pitch Probes"

Dr. Steven Wright, Yang Liu, and Bing Dang (IBM TJ Watson Center)

"Transverse Load Analysis for Semiconductor Applications"

Soheil Khavandi, Jerry Broz (International Test Solutions)

Parker Fellows, Aaron Lomas, Robert Hartley, and Jordan James (University of Nevada, Reno)

Best Presentation, Tutorial in Nature

"Fusion Cuisine" - Hybrid technologies to address MEMS sensors, magnetics and high voltage probing

Dr. Rainer Gaggl and Georg Franz (T.I.P.S. Messtechnik GmbH)

SWTW-2014 Awards

Best Data Presentation

"Low Temperature Test : A low cost design and test methodology to streamline package testing for Automotive IC requirements"

**Daniel Fresquez
(Texas Instruments – Dallas)**

Best Overall Presentation

Probing Study of 80um Grid-array Cu Pillars

Amy Leong (FormFactor)

Alexander Wittig (Globalfoundries, Germany)

Tin Nguyen and Tommaso Masi (FormFactor)

That "Special" Award …


Bill Mann's Poorest Disguised Sales Pitch

*"What happens at SW Test stays at SW Test !!"*

Want to Learn More ?

- **61st IEEE Holm Conference on Electrical Contacts**
  October 11 to 14, 2015, in San Diego, CA
  http://www.ieee-holm.org

- **17th Electronics Packaging Technology Conference**
  December 2 to 4t, 2015, in San Diego, CA
  http://www.eptc-ieee.net

- **Burn In & Test Strategies Workshop**
  March 6 to 9, 2016 in Mesa, Arizona
  http://www.bitsworkshop.org

- **IS-Test Workshop**
  May, 2016 in Freising, Germany
  http://www.is-test.com

- **66th Electronic Components and Technology Conference**
  May 28 to June 5, 2016, in Las Vegas, NV, USA
  http://www.ectc.net

- **ProbeCard Insider**
  Technology Blog by Paul Meyer focused on Probe Cards
  http://probecardinsider.com
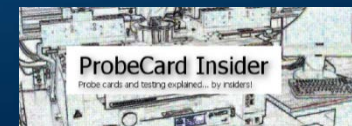
Silence your cell phone !!!
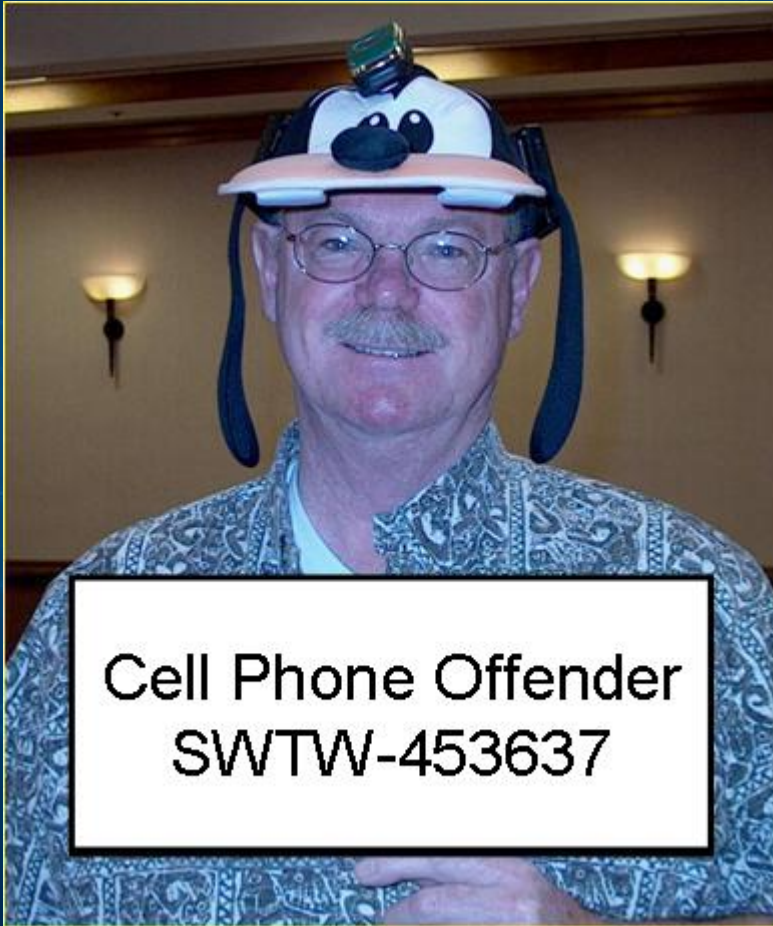
SW Test 2015 e-Proceedings ?

www.swtest.org

Password for Sunday = sandiego
Password for Monday = longmont

- **SW Test Team continues to be focused on a green initiative.**

- **Each day of the workshop will be available for download in a password protected file.**

  http://www.swtest.org
  WiFi Password = aragon2015

- **WiFi will be available during the entire workshop to allow access to website for download.**

- **The daily PDF file password will be announced through the day.**

Thanks for your Support !

- **Contact the SW Test Team with any questions …**

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