2011 iNEMI Roadmap Highlights

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iNEMI - Mission

Mission: Forecast and accelerate improvements in the Electronics Manufacturing Industry for a sustainable future.

5 Deliverables:

- Technology Roadmaps
- Deployment Projects
- Research Priorities
- Proactive Forums
- Position Papers

4 Major Focuses:

- Miniaturization
- Environment
- Alternative Energy
- Medical Electronics

iNEMI is an industry-led consortium of more than 95 global manufacturers, suppliers, industry associations and consortia, government agencies and universities. Visit us at www.inemi.org.

International Members
Across The Total Supply Chain

The International Membership	Incorporated Location; Number of Members			
INEMI Member Business Type	**North America**	**Asia Region**	**Europe**	**Totals**
OEM	14	2	2	18
ODM/EMS (inc. pkg. & test services)	4	7		11
Material Suppliers	8	15	10	33
Equipment Suppliers	7	2	2	11
Universities & Research Institutes	8	2	3	13
Organizations/consulting	9	1	2	12
Totals	**50**	**29**	**19**	**98**

Key Observations Since 1/1/2010

- **160% Growth in University/Research Institutes**
- **60% Growth in Industry Members Overall**
- **Great Global Breadth**
- **Added Many Key Industry Segment Leaders**

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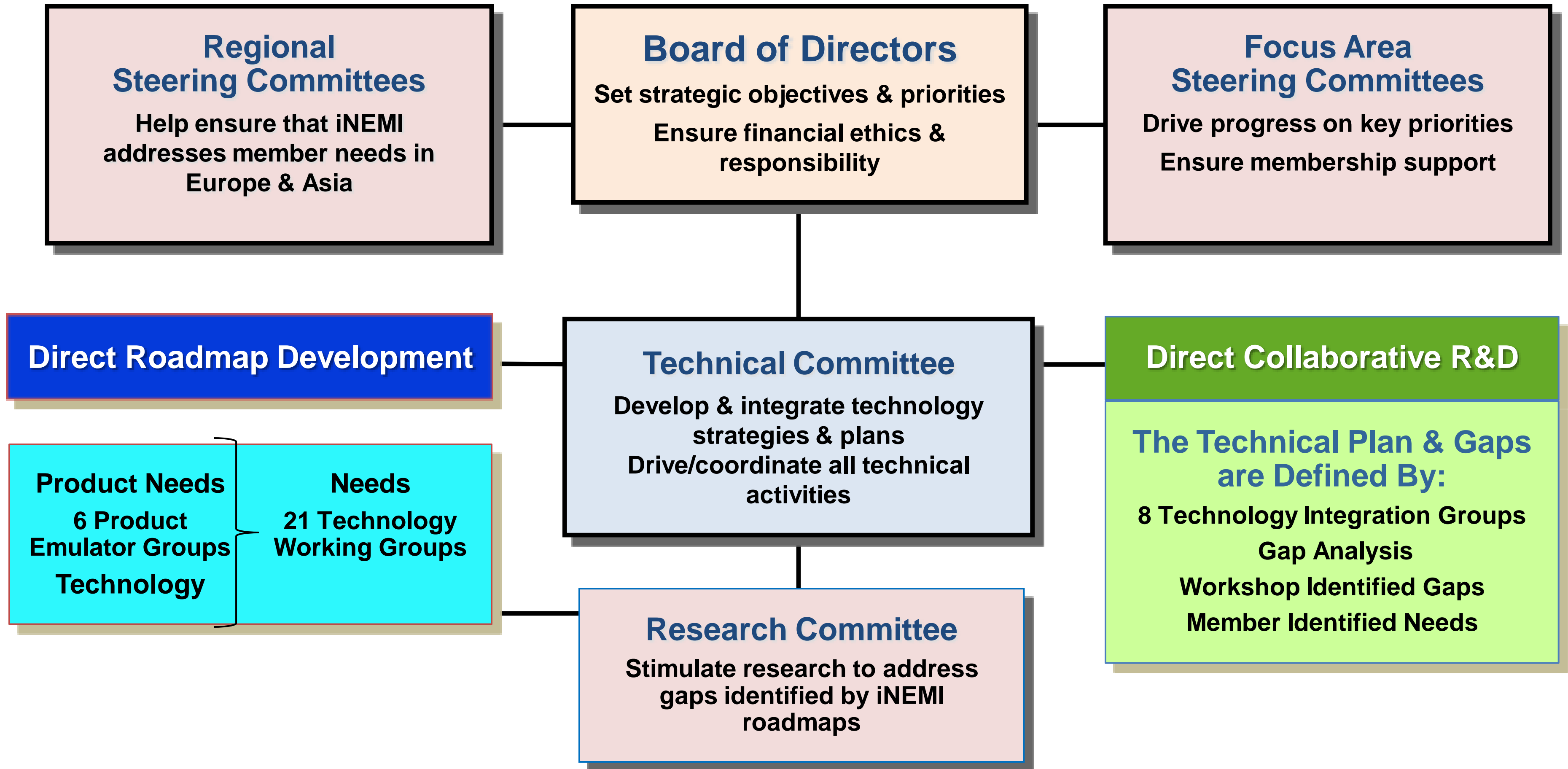
iNEMI Members

iNEMI Organization



Roadmap Process & Scope

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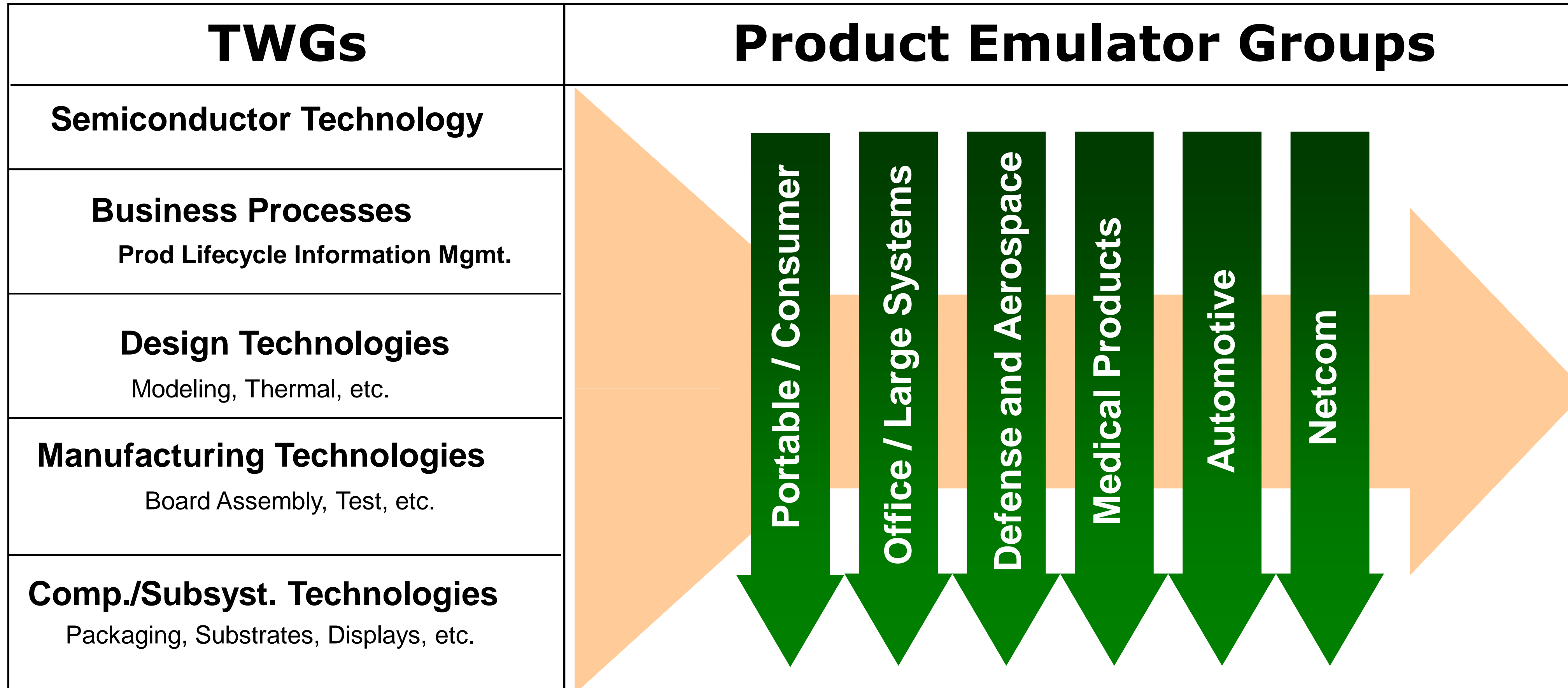
Product Emulator Groups (PEGs)

Industry Sector	Product Characteristics
Automotive	Products that must operate in an automotive environment
Medical	Products that must be highly reliable and, in some cases, support life-critical applications
Consumer/ Portable	Produced in high volumes, cost is the primary driver; hand-held, battery powered products are also driven by size and weight reduction
Office/ Large Business Systems	Driven by the need for maximum performance over a wide range of cost targets
Netcom (Network/ Datacom/ Telecom)	Products that serve the networking, datacom and telecom markets and cover a wide range of cost and performance targets
Aerospace/ Defense	Products that must operate in hostile and high reliability environments

Roadmap Development



Technology Working Groups (TWGs)

Modeling, Simulation, and Design

Connectors

RF Components & Subsystems

Test, Inspection & Measurement

MEMS/ Sensors

Passive Components

Thermal Management

Solid State Illumination

Large Area, Flexible Electronics

Packaging & Component Substrates

Optoelectronics

Semiconductor Technology

Photovoltaics

Mass Storage (Magnetic & Optical)

Ceramic Substrates

Energy Storage & Conversion Systems

Organic PCB

Board Assembly

Final Assembly

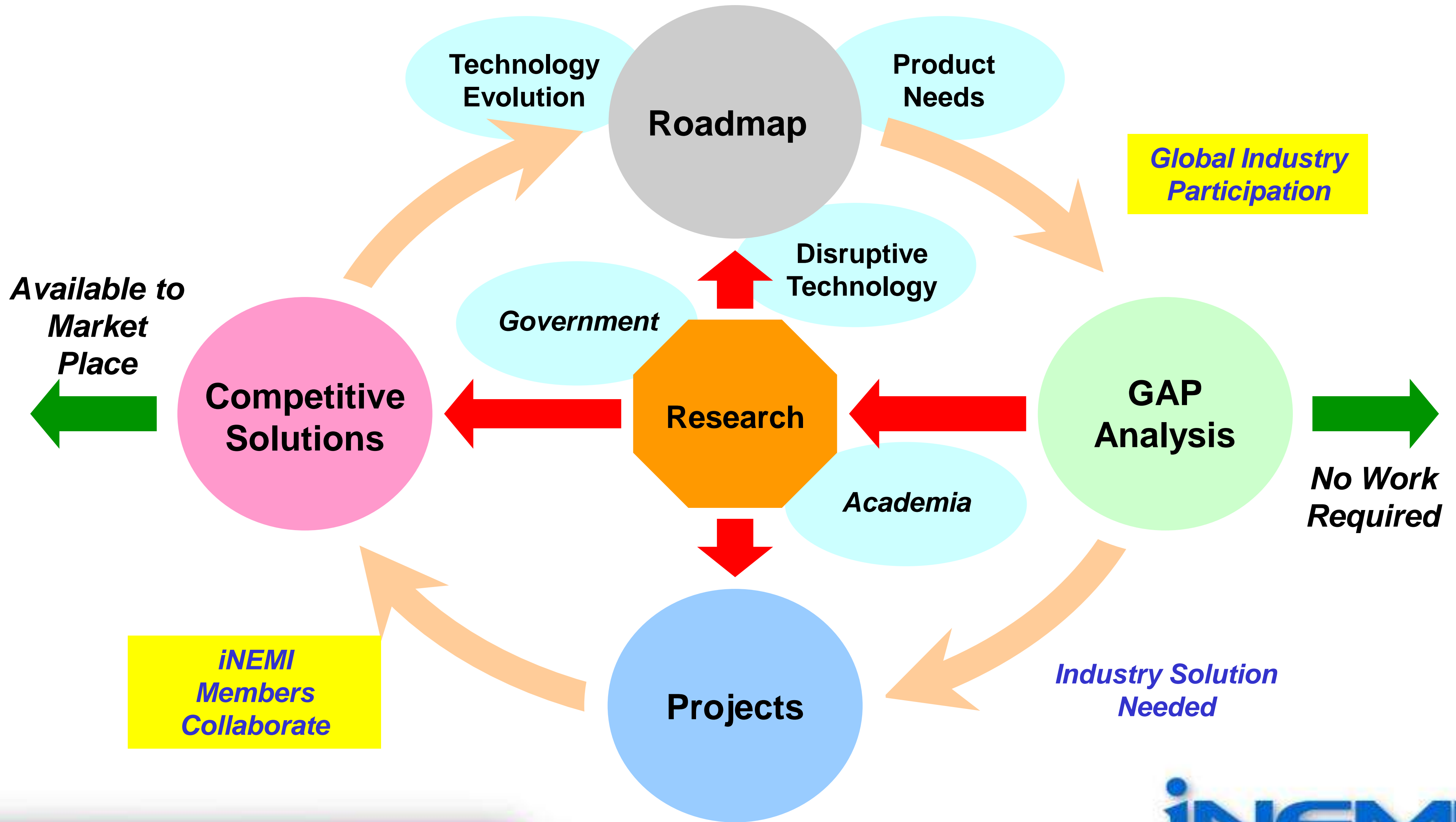
Customer

Information Management Systems

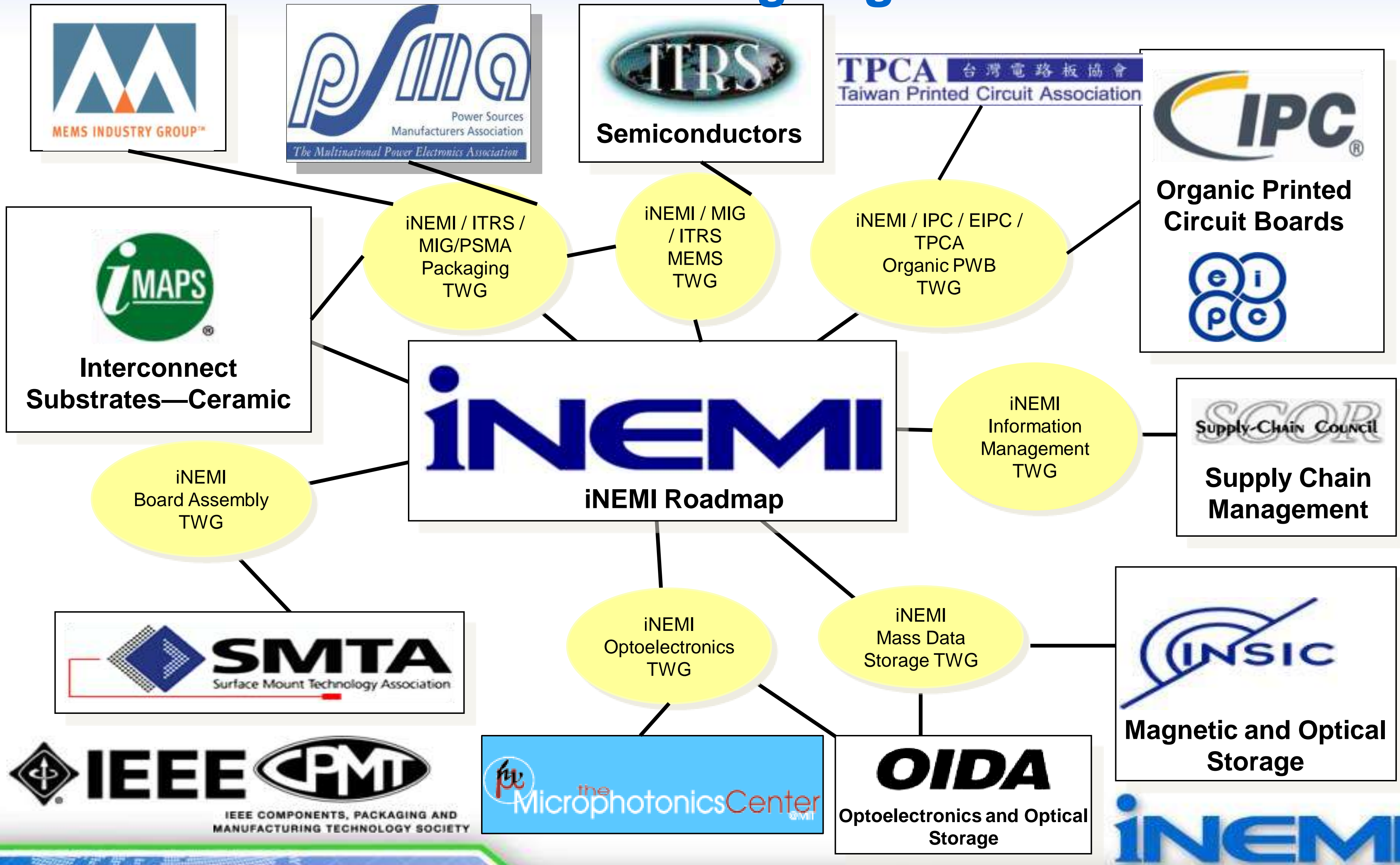
Environmentally Conscious Electronics

Red=Business Green=Design Aqua=Manufacturing Blue=Component & Subsystem

Methodology



Thirteen Contributing Organizations



Statistics for the 2011 Roadmap

- > 575 participants
- > 310 companies/organizations
- 18 countries from 4 continents
- 21 Technology Working Groups (TWGs)
- 6 Product Emulator Groups (PEGs)
- > 1800 pages of information
- Roadmaps the needs for 2011-2021
- Workshops held in Europe (IMEC, Belgium), Asia (TPCA, Taiwan) and North America (ECTC, Las Vegas) in June 2010
- A Full Global Perspective

Visit website www.inemi.org

Situation Analysis

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Situation Analysis
Market

- **No boundaries among computers, communications and entertainment products.**
  - Flat Panel Display is the norm for virtually all applications with touch screen
- **Proliferation of Wireless products**
  - This opens up new applications in a number of segments.
- **Home and office functionality is being added to automotive products**
  - It is growing concerns over driver distraction.
- **Convergence of markets and applications**
  - Medical – Consumer - Automotive – Entertainment – Communication – Computing – Security

$Bn	2009	2011	2013	2015	2021	CAAGR '09-'15	CAAGR '15-'21
Computers and Office	$396	$433	$474	$500	$617	4.0%	3.6%
Communications Infrastructure Equipment	$157	$174	$192	$213	$281	5.2%	4.7%
Consumer and Portable Electronics	$298	$319	$341	$400	$479	5.0%	3.1%
Automotive Electronics	$105	$129	$158	$161	$237	7.4%	6.6%
Medical Electronics	$77	$85	$93	$103	$134	5.0%	4.5%
Military and Aerospace Electronics	$118	$129	$140	$151	$189	4.2%	3.8%
Total Electronics Production	$1,242	$1,382	$1,541	$1,679	$2,171	5.2%	4.4%

Courtesy PrismarK Partners LLC

Situation Analysis
Environmental Regulatory

- **Continuous Regulatory requirements on a global basis**
- **Explosion of new requirements from many regional, national and local governments.**
  - **Manufacturers must remove environmental "Materials of Concern" (endless list of banned materials)**
  - **"High Reliability" product manufacturers are especially vulnerable (new materials)**
  - **Regulatory Challenges for medical electronics market to receive prompt approval of new technology**
  - **Subject to new sourcing and supply chain requirements**
  - **Determination of carbon footprint is an expanding requirement on industry with consistent methodologies.**

Table 4: Partial accounting of materials-of-concern lists maintained by different influential bodies

List	Jurisdiction	Target	Comment
RoHS & Recast	EU and other regions and states that have passed matching legislation	Electronics	Drives Lead – free solder hexavalent Chromium alternatives, eliminates Cd, Hg, and brominated flame retardants
REACH	EU and similar legislation in some Asian countries	Chemicals	New evaluations every six months
TSCA	US EPA – federal legislation	Chemicals	Like REACH and Safer States lists, TSCA is taking direction from biomonitoring studies
Substitute It Now! (SIN)	NGO	Chemicals	Intention is to hasten the transition to a "toxics free world" by influencing global legislation
Proposition 65	California	Chemicals	Covers more than 800 materials; requires labeling on packaging
Coneg – Coalition of Northeastern Governors – Biocides Directive	Eight states: ME, VT, NH, MA, CT, RI, NY, NJ	Packaging components including coatings, inks, and labels;	Cadmium, Lead, Mercury, Hexavalent Chromium
Biocides Directive	EU	cleaners, cosmetics, rodenticides, preservatives, etc.	Recently restricted a common ingredient in desiccant sachets
Greenpeace	Environmental advocacy NGO	Brominated flame retardants and PVC	Includes plasticizers in PVC
Safer States	Consumer products NGO	Brominated flame retardants and endocrine disruptors	May have spillover effect on ICT products; advise monitoring web site for links to biomonitoring studies

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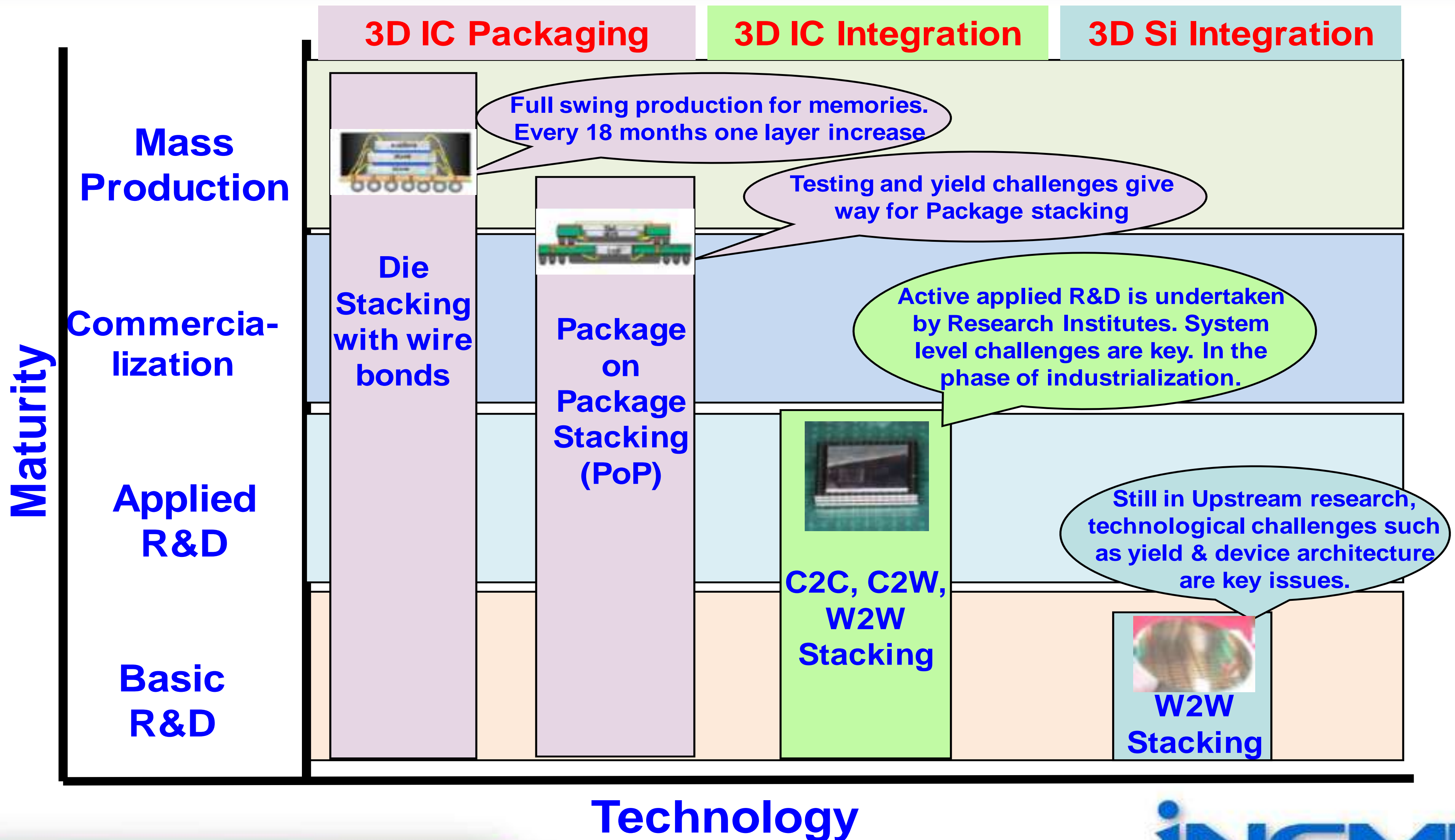
Situation Analysis Technology

- **Multi-core processors are now the norm for most computing applications**
- **Traditional scaling requires improved cooling and operating junction temperature reduction due to large leakage currents.**
- **Consumer’s demand for thin multifunctional products has led to increased pressure on alternative high density packaging technologies.**
- **High-density 3D packaging has become the major technology challenge**
- **SiP:**
  – Technology driver for small components, packaging, assembly processes and for high density substrates
- **New sensors and MEMs:**
  – Expected to see exponential growth
- **RFID:**
  – Replace barcodes and 2D identification
  – Integrate RFID into IT systems for tracking PCBs and system level products
- **3D IC with TSV:**
  – Driven by Performance and Size requirements

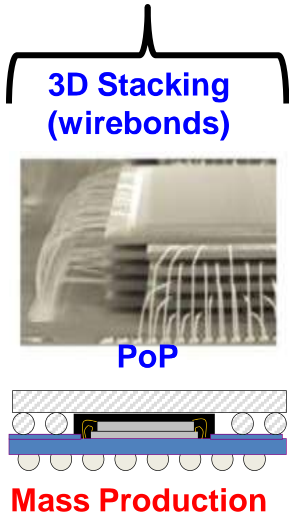
3D Integration Technology



3D Integration Roadmap

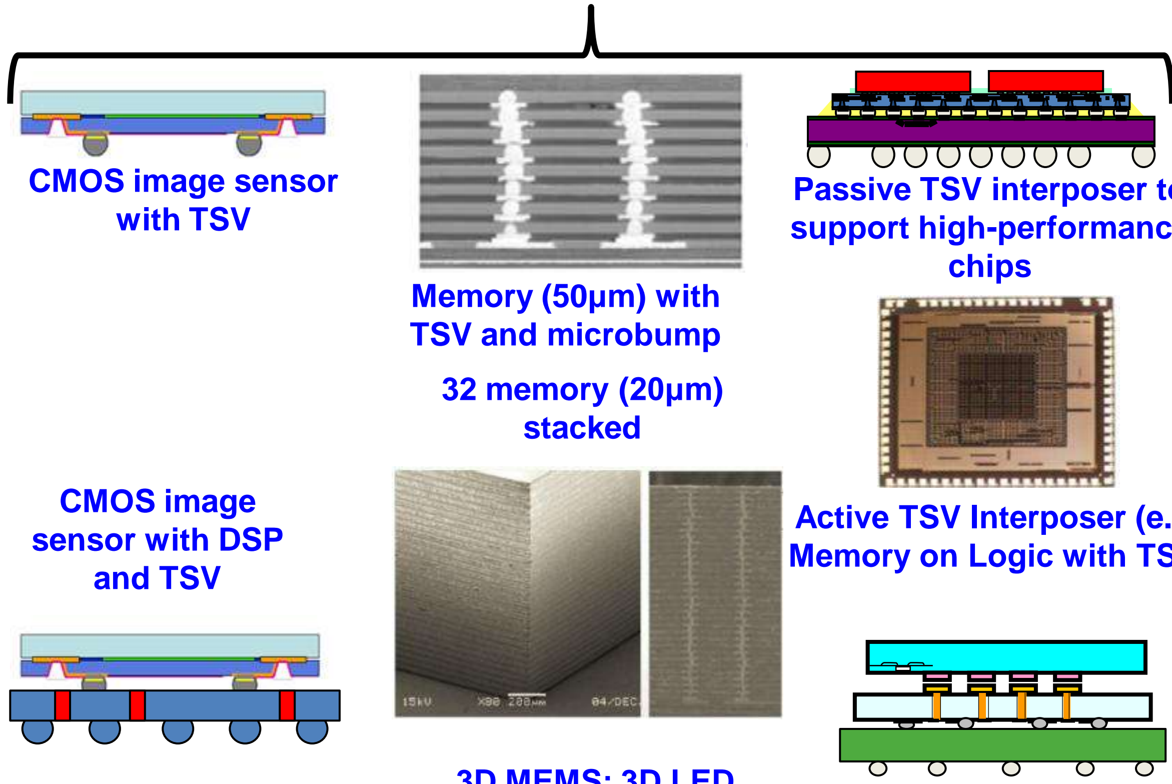
3D Packaging (No TSV)	3D IC Integration C2C/C2W/W2W; microbump bonding; 5 ≤ TSV ≤ 30µm; 20 ≤ memory stack ≤ 50µm; 100 ≤ interposers ≤ 200µm	3D Si Integration W2W pad-pad bonding (TSV ≤ 1.5µm)

3D Stacking (wirebonds)



PoP

Mass Production



CMOS image sensor with TSV

Memory (50µm) with TSV and microbump

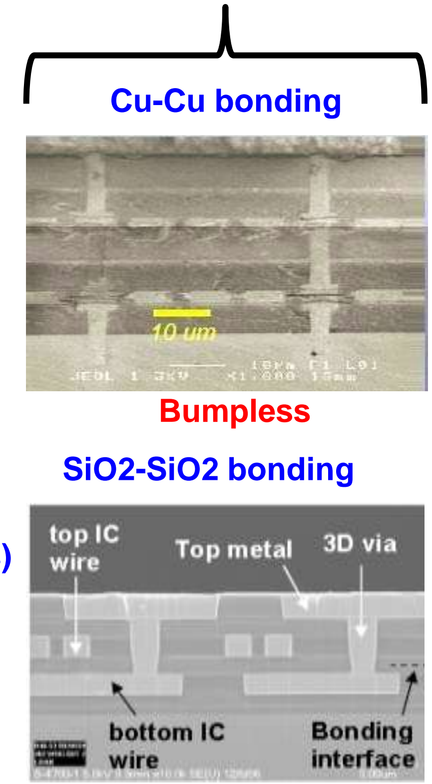
Passive TSV interposer to support high-performance chips

32 memory (20µm) stacked

CMOS image sensor with DSP and TSV

Active TSV Interposer (e.g., Memory on Logic with TSVs)

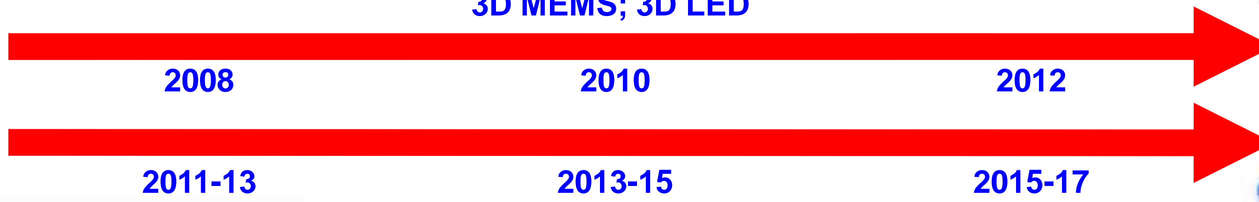
Cu-Cu bonding



Bumpless

SiO2-SiO2 bonding

3D MEMS; 3D LED



Low Volume Production — 2008 — 2010 — 2012 — Bumpless

Mass Production — 2011-13 — 2013-15 — 2015-17 — Don't care to guess!

Low volume production = only a handful of companies are SHIPPING it;
Mass production = many companies are SHIPPING it.

Strategic Concerns

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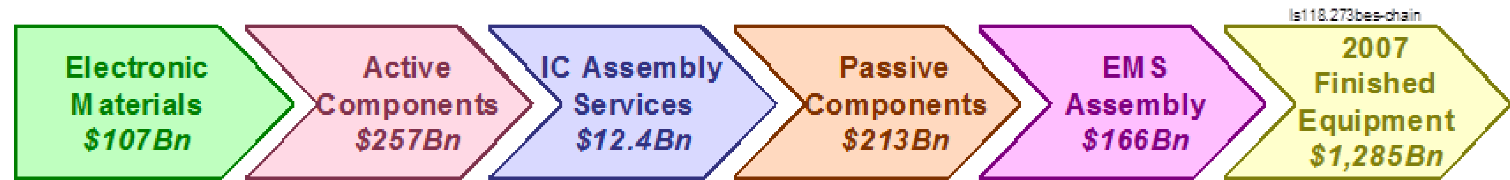
Value Creation in The Supply Chain



	Electronic Materials	Active Components	IC Assembly Services	Passive Components	EMS Assembly	Finished Equipment
Typical Companies	Sumitomo Bakelite, DuPont, Henkel	Intel, STMicro, LSI Logic	Amkor, ASE, SPIL	Tyco, Molex, AVX, Sharp	Sanmina-SCI, Flextronics, Jabil, Hon Hai	Dell, HP, Cisco, Nokia, Teradyne, Visteon, Siemens
Gross Margin	40%	40%	17%	25%	6%	30%
Operating Margin	10%	10%	8%	8%	2%	8%
R&D	7%	10%	2%	3%	< 1%	3%
Margin Value	$11Bn	$26Bn	$0.2Bn	$17Bn	$3Bn	$103Bn
R&D Value	$5Bn	$26Bn	$0.2Bn	$6Bn	$1Bn	$38Bn
%Total R&D	7%	34%		8%		51%

Strategic Concerns

- **Restructuring from vertically integrated OEMs to multi-firm supply chains**
  - Resulted in a disparity in R&D Needs vs. available resources
- **Critical needs for R&D**
  - Middle part of the Supply Chain is least capable of providing resources
- **Industry collaboration**
  - Gain traction at University R&D centers, Industry consortia, “ad-hoc” cross-company R&D teams
- **The mechanisms for cooperation between industries must be strengthened.**
  - Cooperation among OEMs, ODMs, EMS firms and component suppliers is needed to focus on the right technology and to find a way to deploy it in a timely manner
- **Need to formulate ways to adopt and develop emerging technologies into the board assembly process and higher functional units.**
  - With manufacturing R&D responsibility transitioning to the EMS companies in low cost geographies
- **Impact that electronics products may exert regarding safety, energy usage and environmental footprint**
  - Conflicting sources of public information can cause confusion and less-than-optimum solutions
- **International standardization.**
  - Harmonization of environmental regulations for electronic products is a must
- **Disruptive technology offers opportunity for innovation.**
  - Supply chain must be willing to invest with a long-term perspective in mind

Highlights of PEGs

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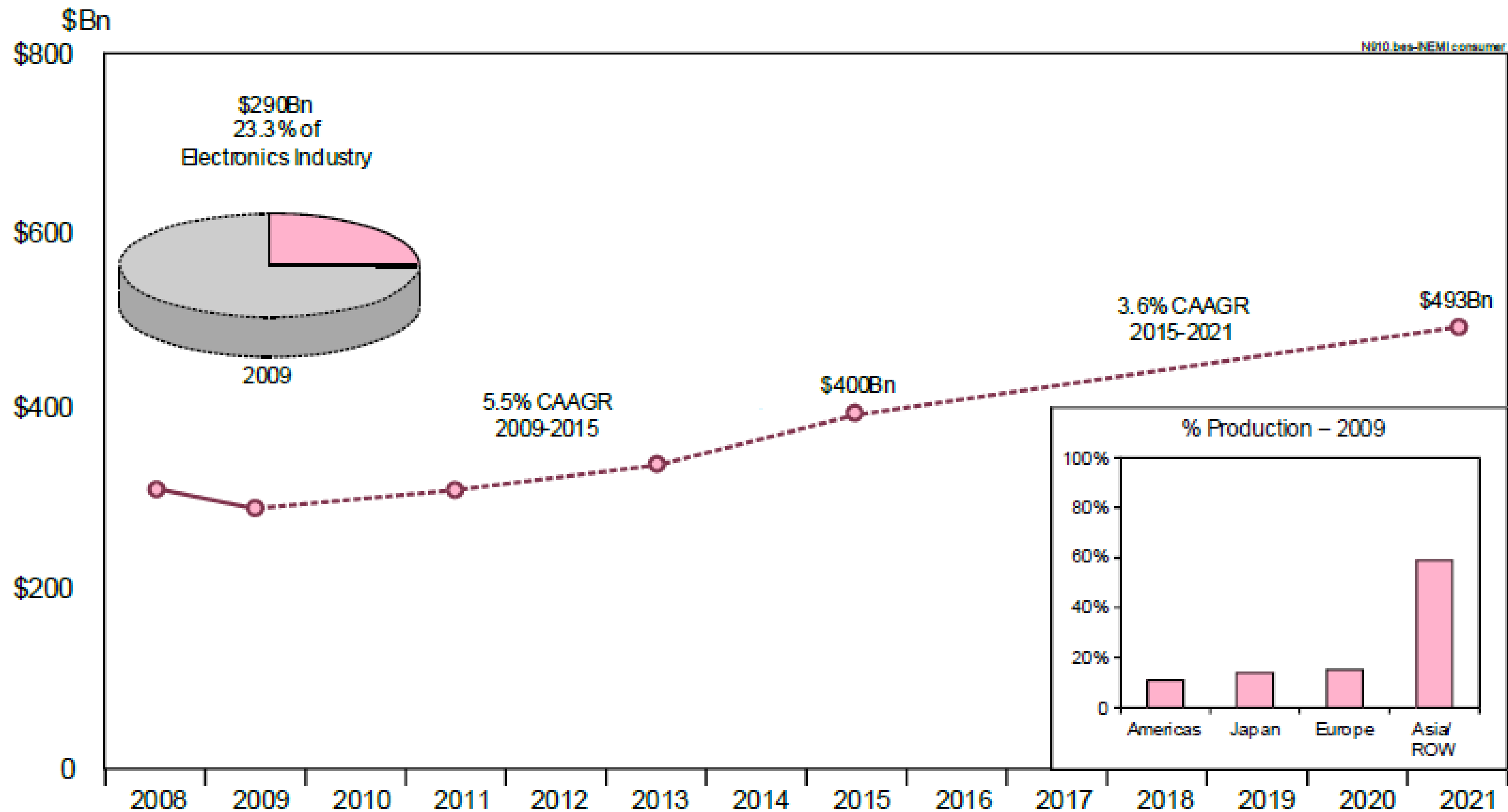
Portable and Consumer Electronics



Portable and Consumer Electronics
Two Major Segments

- **Portables**
  - Mobile phones, digital cameras, camcorders, PDAs
- **Non-Portables**
  - Televisions, VCRs, DVD players, stereos

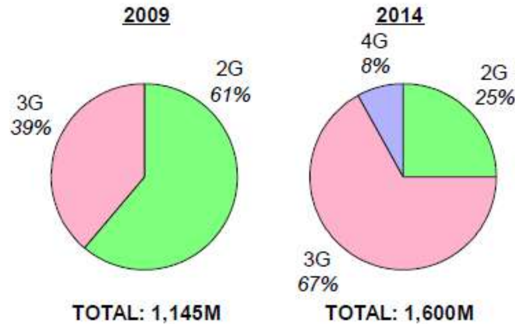
Highlights

- **Continued evidence of market saturation in key product segments (e.g., mobile phones and digital cameras)**
  - Decreasing average selling prices but improving economic conditions
- **Strong sales of certain products such as LCD TVs and smartphones**
- **Smart phones dominate unit volume growth for portable products and the overall market volume growth is driving Technology Development areas:**
  - Increased focus on shrinking form factor and low power
  - High level of integration (SoC, SiP)
  - 3D packaging and Embedded Die market leaders
  - Significant focus on sustainability, eco-design and recycling
  - The MEMS/sensor technology for unleashing entertainment, medical, and security as well as perceptual computing
- **Convergence of Entertainment, Computing, Communication drives integration**
  - The worlds of OS, applications and middleware challenges will drive major shifts and consolidations to enable seamless computing and interoperability
  - The pace of product enhancement is growing rapidly.

Mobile Phone

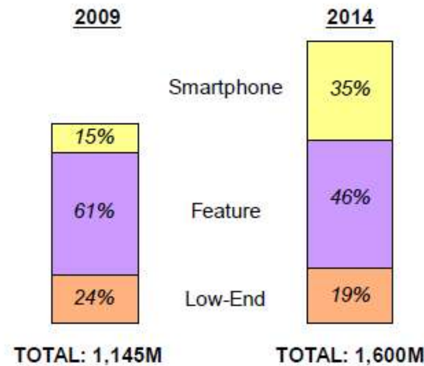
MOBILE PHONE MARKET DEVELOPMENT

310.10/146mvc



TOTAL: 1,145M   TOTAL: 1,600M

- Continuing move to faster standards
- First 4G networks commercial in December 2009



TOTAL: 1,145M   TOTAL: 1,600M

- Strong growth of smartphones
- Features also trickle down to others

GOOGLE NEXUS ONE SMARTPHONE

- SoC and SiP integration reduced parts count
- New bands, functions increase parts count

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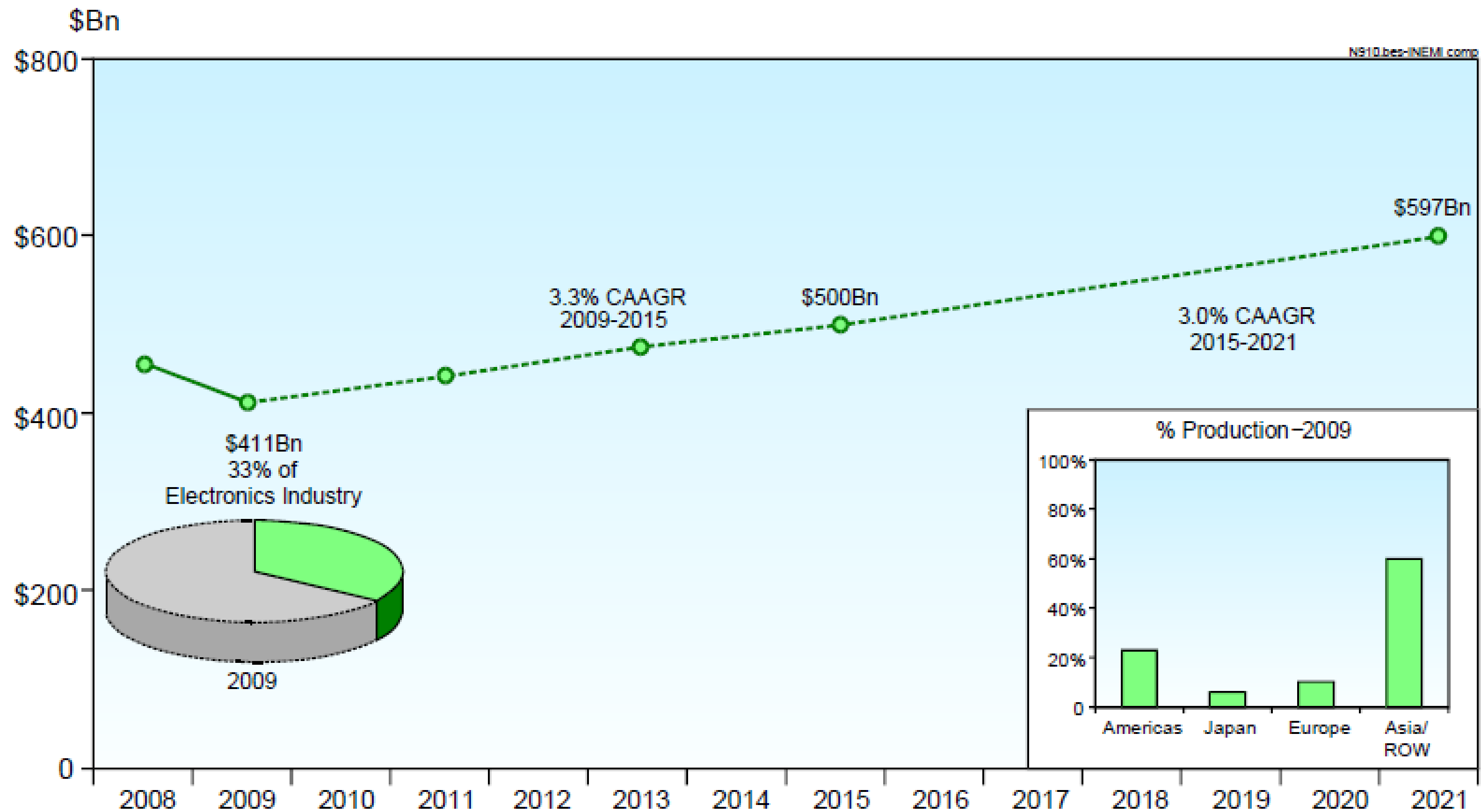
Computers and Office Systems



Computers and Office Systems
Four Major Segments

- **Computers:**
  - Desktop PCs, Notebook PCs, Workstations, Servers
- **Computer Peripherals:**
  - printers, scanners, keyboards, monitors, PC cameras
- **Storage Systems:**
  - hard disk drives, SAN/NAS
- **Office Equipment:**
  - photocopiers, fax machines, digital projectors

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Highlights

- **Trend to denser systems desired but cost remains key barrier**
  - Cost
    - Notebook volume to overtake Desktop – 3:1 by 2015
    - Continued pressure on system ASPs – notebook cost pressure accelerating
    - HDI board technology is not gaining ground
  - Demand continues for smaller form factors everywhere
    - x, y and z-height is valued
  - Netbooks/Tablets filling the gaps - delivering on both cost and form factor

- **Environmental**
  - HFR Laminate PC adoption timeline
    - Early adopters – 2009 – higher end segments
    - Volume adoption 2011 – mainstream segments

- **Number and speed of I/O continues to scale**
  - Driven by increased system capability and continued system silicon integration (SOCs, SiPs, MCPs, MCMs…)
  - System bus speeds exceeding FR4 capability on the horizon.
    - Limited use of optical and other Off-board technologies will seek to extend FR4 life/cost structure

Highlights - continued

- **Client/Office power trending to down over time**
  – Demand drivers: battery life and energy cost
  – Solutions targeting power efficient silicon processes and lower power processing architectures

- **Server power scaling slightly up at the chip level, but system power density scaling faster**
  – Increase in cores/chip
  – Sockets/rack continues to increase
  – Recent focus on Perf/W eclipsing Perf/$
  – Market will bear ~$7 increase per Watt saved (driven by current energy costs)
  – Trend toward virtualization resulting in higher average power levels
  – Energy efficient features will stress mechanical interconnects (delta of avg power and saving modes)
- **Thermal management demand continues**
  – Increased heat flux coupled with non uniform heating affects
  – Enabling denser, smaller form factors
  – Desire for higher ambient temperatures

Communications Infrastructure Equipment

$Bn

$400

$300

$200

$100

0

$138Bn
11.1% of
Electronics Industry

2009

7.5% CAAGR
2009-2015

$213Bn

6.0% CAAGR
2015-2021

$303Bn

% Production – 2009

100%
80%
60%
40%
20%
0

Americas
Japan
Europe
Asia/
ROW

2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021

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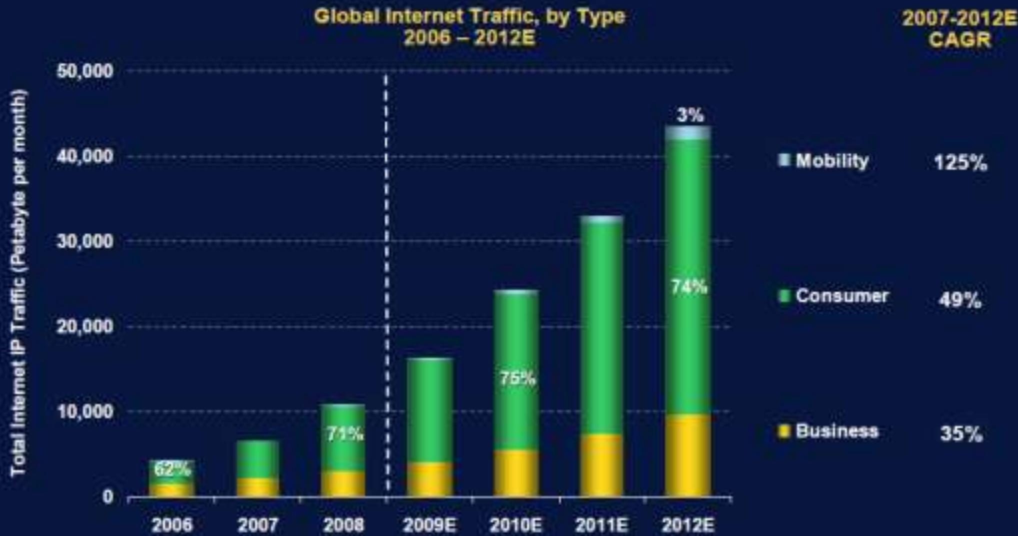
Communications Infrastructure Equipment Three Major Segments

- **Small Office/Home Equipment:**
  - low-end switches and routers, modems
- **Enterprise Equipment:**
  - mid-range switches and routers, PBXs, VoIP phones
- **Service Provider Equipment:**
  - wireless base stations, central office switches, cable modem termination systems, VoIP and IPTV equipment, core routers, WiMAX

Highlights

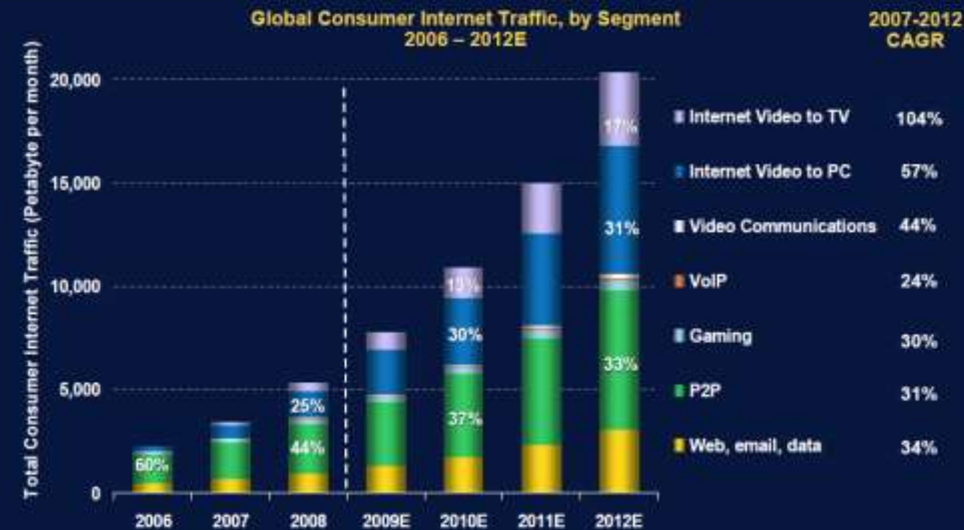
- **Most Growth - Equipment Segment:**
  - SOHO, enterprise, and wireline infrastructure
  - Driven by increased consumer demand for broadband services.
  - Wireless infrastructure equipment driven by 4G
- **High-growth system**
  - Wireless LAN, service provider routers and multi-service switches, metro optical networks, Voice over IP (VoIP), and IPTV equipment.

Drivers for Networking Products

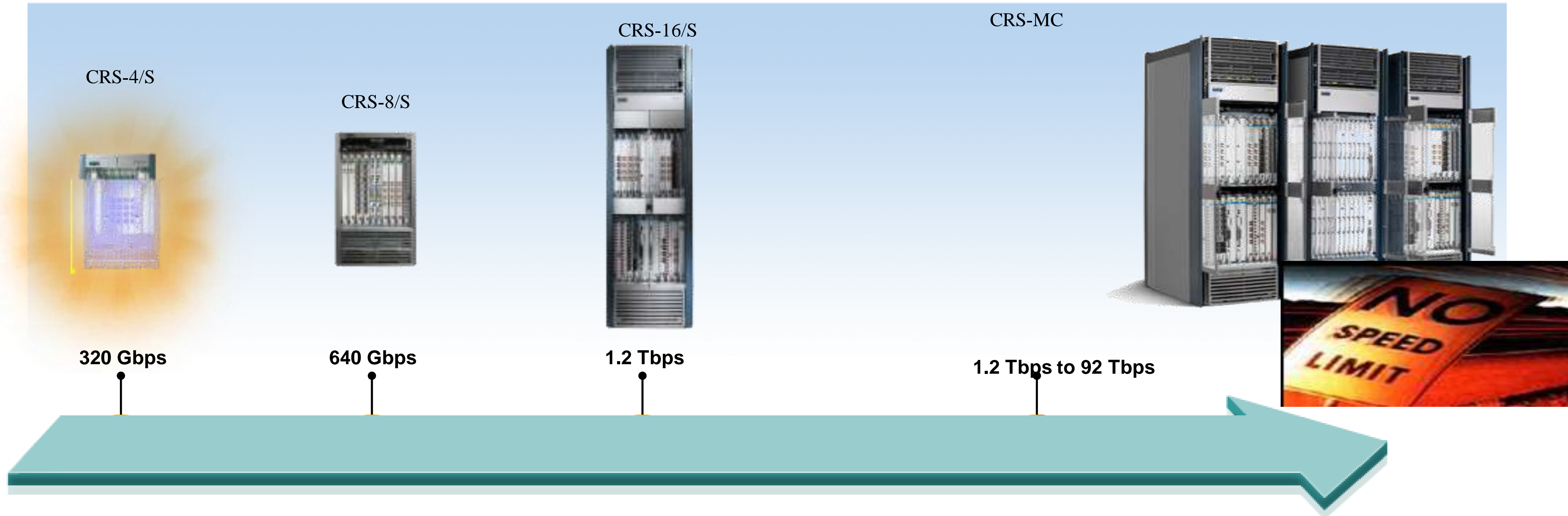


Consumer is driving internet traffic

Video is leading the consumer internet traffic growth



It’s all about Bandwidth



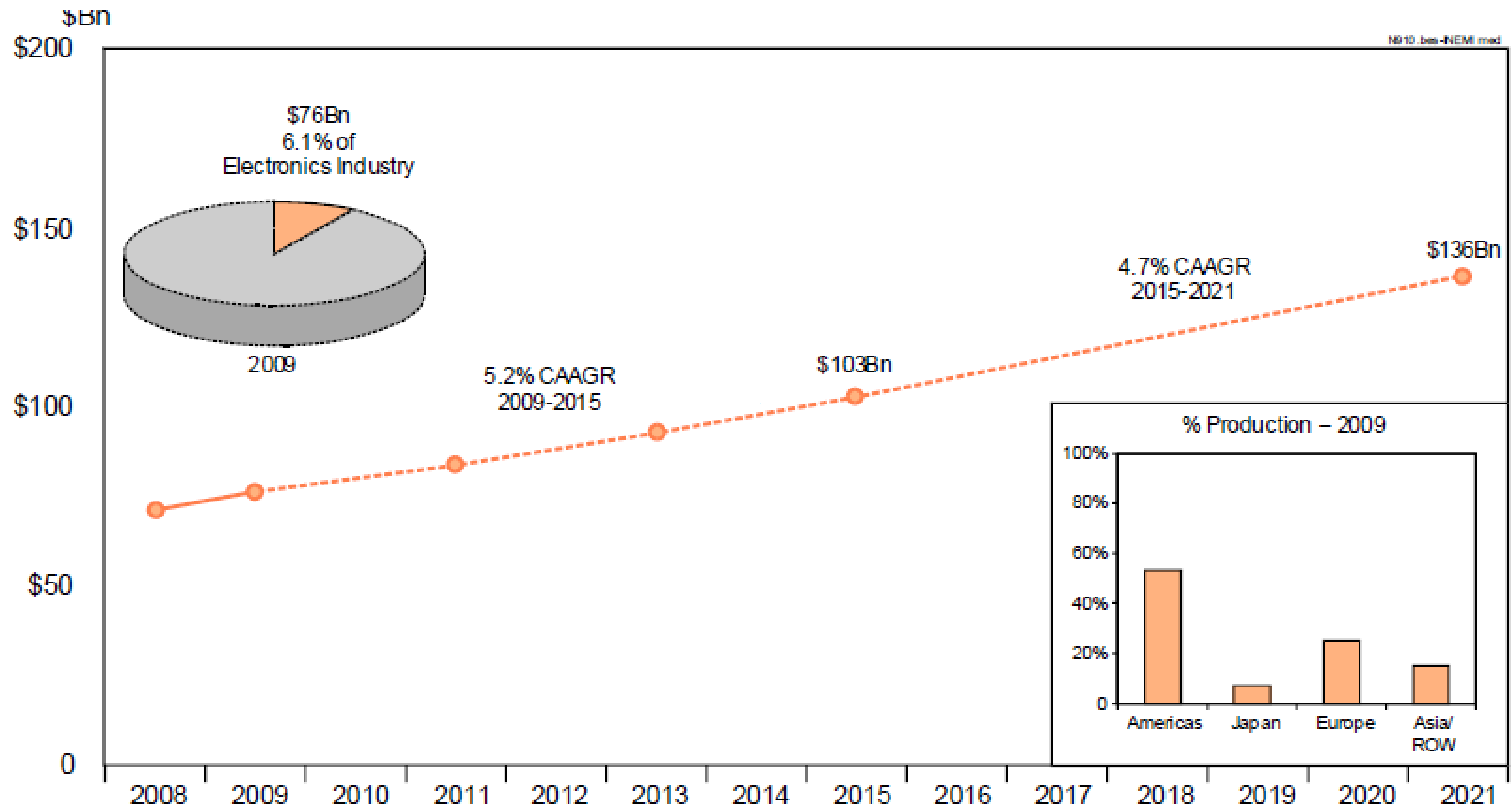
What technology is needed for at least 10x improvement for each product generation:

- **BW capacity, density,**
- **Power efficiency (bps/W),**
- **Cost efficiency (bps/$)**

Where are we today – Component Technology

- **Device technology constraints:**
  - Silicon (die size limited)
  - Optics (O/E conversion)
  - Maturity/risk
- **100 M + gates, > 20mm + die with core voltages < 1.0 V**
- **Chip to chip interfaces become serial**
- **Huge PCBs**
  - 21.5x18" 34+ layers
  - Board real estate
- **High-speed & specialized memory**
  - DDR3, TCAM4, …
- **Silicon scaling does not translate to linear performance improvement**
  - Si solutions:
    - Half node shrink to 40 and 28 nm
    - SOI
- **Packaging needs to help scale performance – device/system optimization**

Medical Electronics System



Medical Electronics System
Three Major Segments

1) Implanted products (devices implanted in a human body)

- Strict regulatory procedures
- Driven by battery life (low power loss) – this limits the use of certain components such as DRAM due to high energy consumption
- Validation and traceability required
- Long term reliability paramount
- Long development cycles, primary assembly and design by OEMs

2) Portable products (devices that are easily transported)

- Cost parity with consumer / portables
- Dynamic market, needs fast response, 9 to 24 month product cycle time
- Mixed regulatory environment
- Mostly outsourced assembly and design
- Higher Volume; Lower Cost – example – diagnostic ultrasound in PDA size .. and smaller .. form factors

3) Diagnostic imaging devices and large scale equipment, e.g., MRI, CT

- Larger scale (often similar to servers or telecom equipment)
- Challenging thermal management and heat sinking
- Utilizes commercial off-the-shelf components, when available
- Development cycle is shorter than implantable
- Application and design well suited to EMS environment

Medical Market

- **Global**
  - 65+ year old population will triple by 2050 .. from 516M (2009) to 1.53B (2050)
  - 80+ year old population will increase from 40M (2009) to 219M (2050)
- **Currently, the U.S. (for example) spends 1.75 Trillion dollars … 15% of 2009 GDP … 25% of GDP 2015**
- **It is estimated that current annual spending on medical devices / electronics is 70 to 100 Billion dollars**
- **The market opportunities are large and are growing**

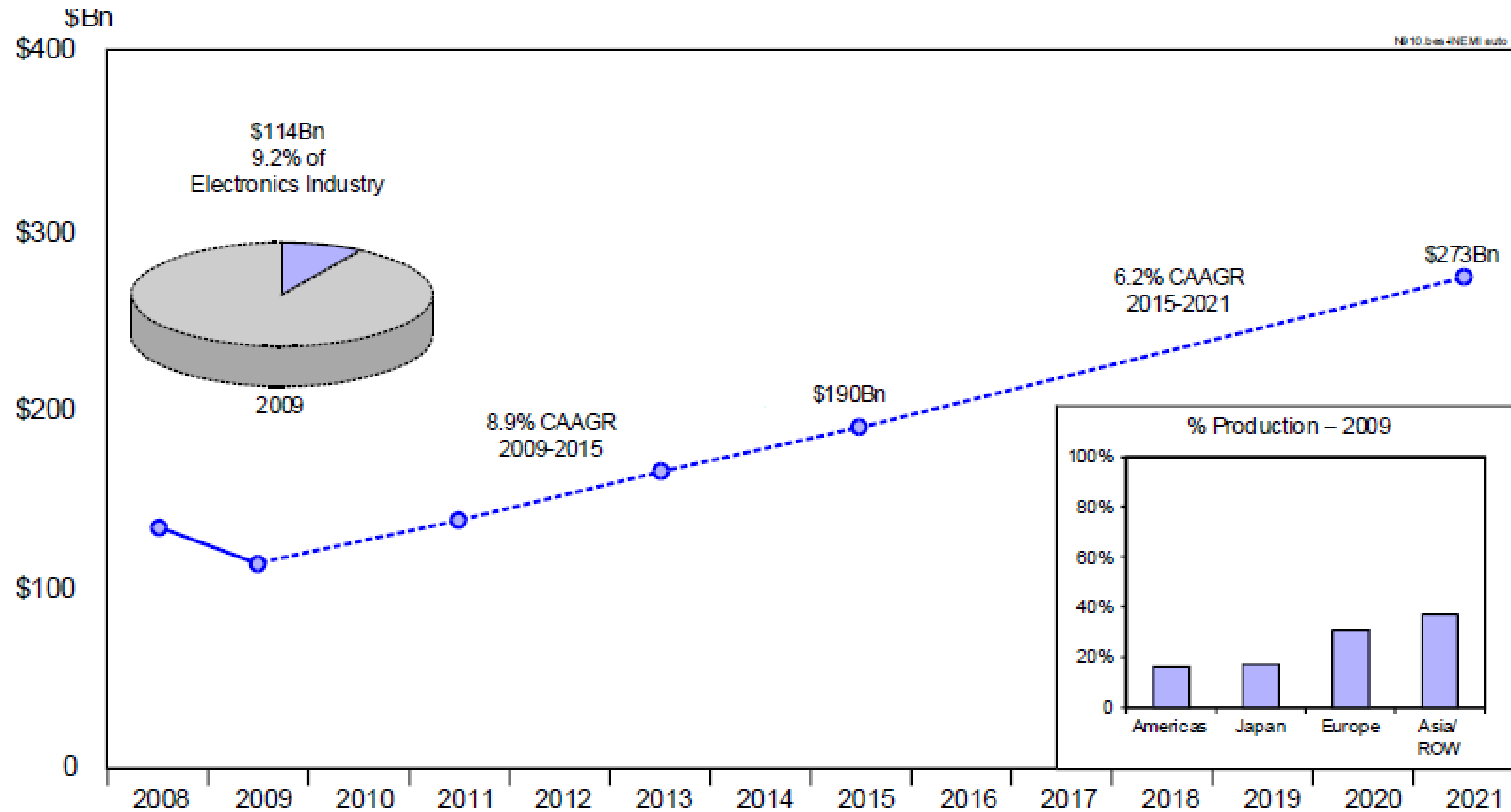
Leverage off Other Market Segments

- **Implantable market reliability methods can learn from…**
  - Auto & Military – Learning on harsh environment reliability in shock, impact and long term low level fatigue
- **Portables – wireless medical device systems now becoming standard**
  - Personal data device transmits medical monitoring facility and physician – communication must be flawless
  - SIP and POP in consumer products- Some learning but additional work needed to better correlate with medical product needs
- **Imaging Systems rely heavily on high end telecom system components**
  - Displays, mass storage, wireless and hard-wire data transfer systems

Critical Gaps and Challenges

- **Connector technologies that are highly reliable**
  - Ultra small for implantable products with automated wire attach. Also require ultra high fidelity signal properties
  - Large geometry connectors for imaging systems with superior contact quality – zero electron loss
- **Safety and efficacy in RF traffic wireless telemetry.**
  - Different frequencies, pulse widths, etc. in medical device settings are not thoroughly addressed in international standards
- **High reliability (10 year life minimum) PCB technologies to support high density high performance silicon in implantable – major research need**
- **High performance energy storage methodologies**
  - Includes researching and refining energy harvesting the bodies thermal and motion attributes
- **Addressing critical business issues for the medical market:**
  - Conversion to alternative to Pb solder attach technologies
  - Simplifying regulatory and time to market challenges

Automotive Electronics



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Automotive Electronics
Six Major Categories

- **Powertrain Electronics**
  - engine controllers, transmission controllers, voltage regulators, and any other systems that control the engine or driveline of the vehicle
- **Entertainment Electronics**
  - AM/FM radios, on-board video entertainment systems, satellite radio receivers
- **Safety and Convenience Systems**
  - Airbag sensors, climate controls, security and access controls, anti-lock braking systems
- **Vehicle and Body Controls**
  - Suspension, traction, power steering
- **In-Cabin Information Systems**
  - Instrument clusters, trip computers, telematic products
- **Non-Embedded Sensors**
  - Speed sensors, temperature sensors, fluid level sensors, and many others

Highlights

- **Stricter fuel economy and emissions mandates**
- **Legislated requirements for advanced safety systems**
  - Advanced airbags and on-board tire pressure monitoring
- **Greater vehicle efficiencies**
  - Driven by escalating global crude oil prices
- **Greater safety, comfort, and convenience features**
- **Luxury features**
- **Growth of hybrid and electric vehicles**
- **Key Drivers: cost, reliability, size**
  - Cost is still the key driver for automotive
    - Competitive cost will get you an opportunity to win a program
  - Reliability is a given in the automotive sector
    - Failure to deliver will result in no future business
  - Size is a benefit because some vehicles having 100 electronic controllers and space is limited

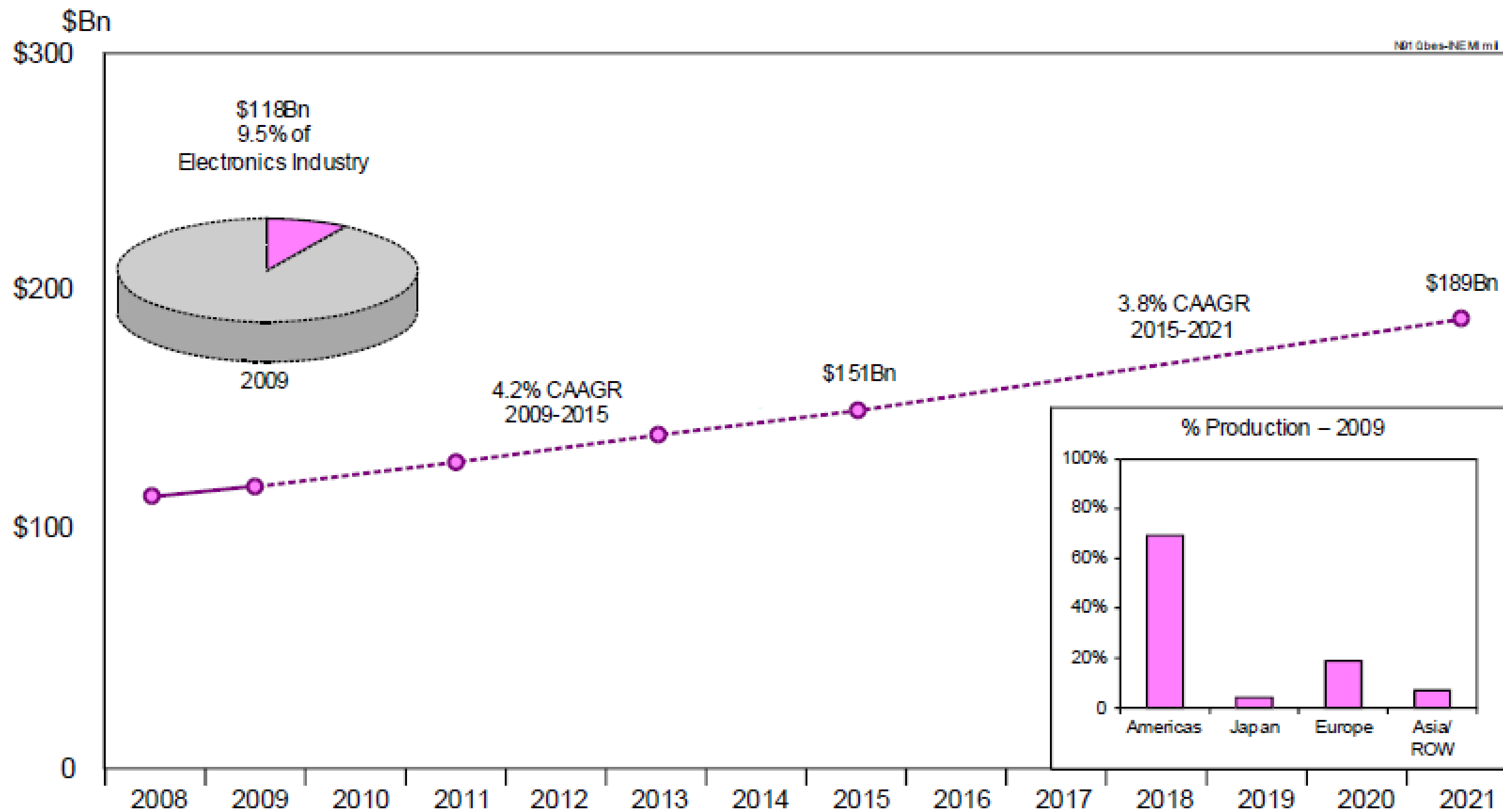
Business Issues

- **Reduced North American volume in 2009 (worst year in 30 years)**
- **Western Europe sales at a full-year rate near 14.7 million units for 2009, 2010 volume expected to be reduced to 13.7 million units**
- **Japan sales declined to the lowest level in 38 years (2.9 million units)**
- **China exceeding the U.S. in auto output in 2009 (12 million units)**
  - Up 34 percent from a year earlier
- **Increased Corporate Average Fuel Economy to 35.5 mpg by 2016**
  - Downsizing of engines and increased use of Gas Direct injection
  - Increased use of turbo-charging
  - Researchers project 14 million electrified vehicles annually by 2020

Technical Issues

- **Shift to Hybrid Electric Vehicles (HEV), Plug-in Hybrid Electric Vehicles (PHEV), and Electric Vehicles (EV)**
  - Invention required to reach the battery cost target of $250/kWh
    - Today’s cost $1,000 -$1,200/kWh
  - Key components that are in need include: power devices, bulk capacitors, inductors and transformers, cooling structures, motor drive microprocessors, high current connectors, current sensors, gate driver ICs, battery management ICs, bus bars, and enclosures.
- **Increased use of MEMS in automotive**
  - Accelerometers
  - Gyroscopes
  - Pressure
  - Air Flow
- **12.3 inch reconfigurable displays for the instrument panel**
- **LED lighting used internally and externally**
- **Connected Vehicle**

Military and Aerospace Electronics



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Roadmap Highlights

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IC Package Unit Growth

Figure 1: World Wide Semiconductor Package Volume (billions of units)

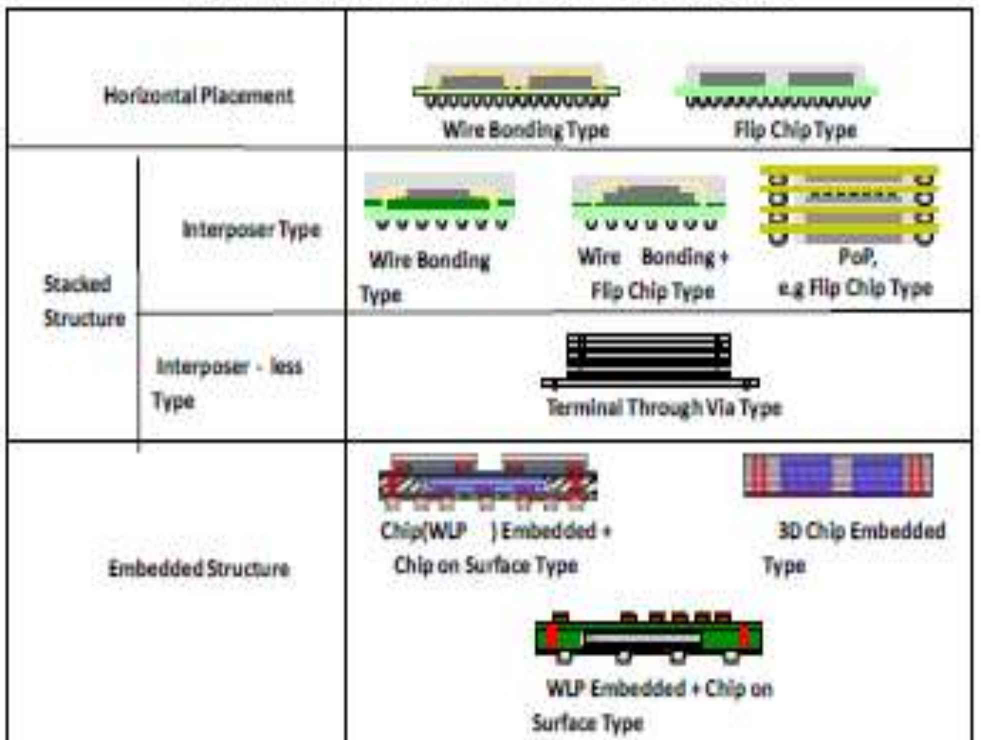
OVERVIEW OF IC PACKAGE UNIT GROWTH

Source: Prismark

Package Type (Bn Units)	2008	2009	2014	2009 – 2014 CAAGR	% of Total IC 2014
DIP	6.0	5.3	3.5	-7.8%	1.6%
SO	72.4	67.3	85.0	4.8%	38.8%
QFP/LCC	17.7	14.8	16.7	2.5%	7.6%
QFN	12.8	13.7	35.3	20.9%	16.1%
Wire Bond FBGA	16.6	15.3	25.1	10.4%	11.4%
Stacked FBGA	4.1	3.7	6.6	12.4%	3.0%
Wire Bond BGA	1.2	1.1	1.3	5.1%	0.6%
COB (Wire Bond)	7.3	6.6	10.3	9.1%	4.7%
Flip Chip FBGA	0.20	0.3	1.7	38.8%	0.8%
Flip Chip BGA/LGA	0.93	0.9	1.4	7.9%	0.6%
DCA/WLCSP	8.9	9.0	22.4	20.0%	10.2%
COF/COG/TAB	7.3	6.8	9.7	7.5%	4.4%
Total Flip Chip	17.3	17.0	35.1	15.6%	16.0%
Total Wire Bond	138.0	127.6	183.8	7.6%	84.0%
IC Total	155.3	144.6	218.9	8.6%	100.0%

Prismark LLC

System in Package (SiP)



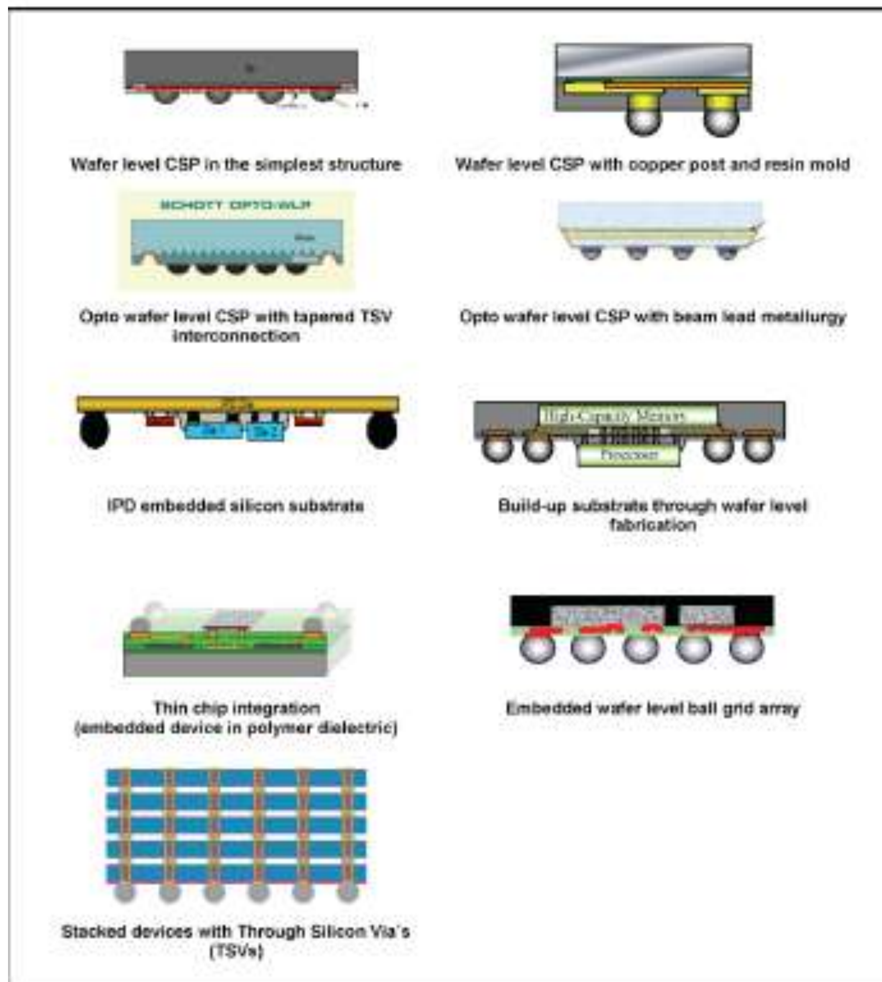
SYSTEM IN PACKAGE (SiP) FORECAST

Package Type	2009				2014			
	Units (M)	Package ASP ($)	Package Value ($M)	% of Value	Units (M)	Package ASP ($)	Package Value ($M)	% of Value
MPU/Logic MCM (side by side Flip Chip, Logic Centric)	35	8.00	280	5%	100	7.00	700	8%
Package on Package (PoP, PiP, Logic Centric)	245	1.85	453	8%	640	1.50	960	10%
Connectivity Module (Logic Centric)	311	0.49	151	3%	728	0.65	470	5%
Stacked Die in Package (Logic Centric)	1000	0.90	900	17%	1820	0.81	1474	16%
Subtotal (Logic Centric)	*1591*	*1.12*	*1784*	*33%*	*3288*	*1.10*	*3604*	*39%*
Stacked Die in Package (Memory Centric)	3900	0.65	2535	47%	5830	0.60	3498	38%
Multi-Die in Leadframe (Power and RF Centric)	550	0.25	138	3%	1100	0.25	275	3%
Mobile RF Module (RF Centric)	2390	0.20	485	9%	4450	0.19	857	9%
MEMS MCP (MEMS Centric)	600	0.75	450	8%	1300	0.70	910	10%
Subtotal (Non-Logic Centric)	*7440*	*0.48*	*3608*	*67%*	*12680*	*0.44*	*5540*	*61%*
Total	9031	0.60	5392	100%	15968	0.57	9143	100%

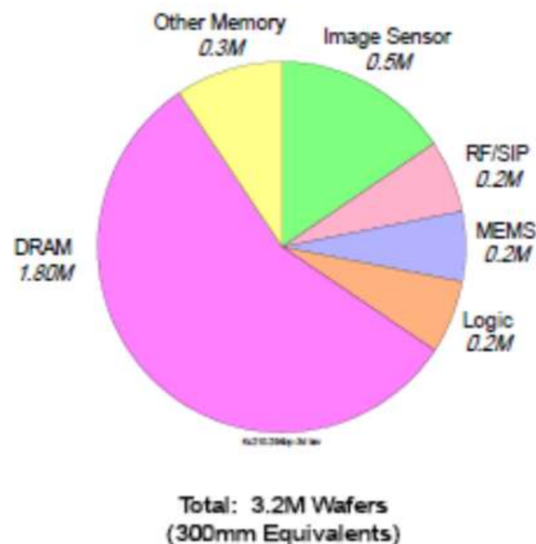
Package value includes substrate, assembly, passives, and flip chip lid attach. Wafer bumping is excluded.

Wafer Level Packaging

Figure 4: Examples of Wafer Level Packaging Types



3D/TSV WAFER FORECAST – 2014



Total: 3.2M Wafers
(300mm Equivalents)

2014
PENETRATION
(% OF TOTAL WAFERS)

Image Sensor	90%
RF/SIP	15%
MEMS	20%
Logic	< 1%
DRAM	7%
Other Memory	1%

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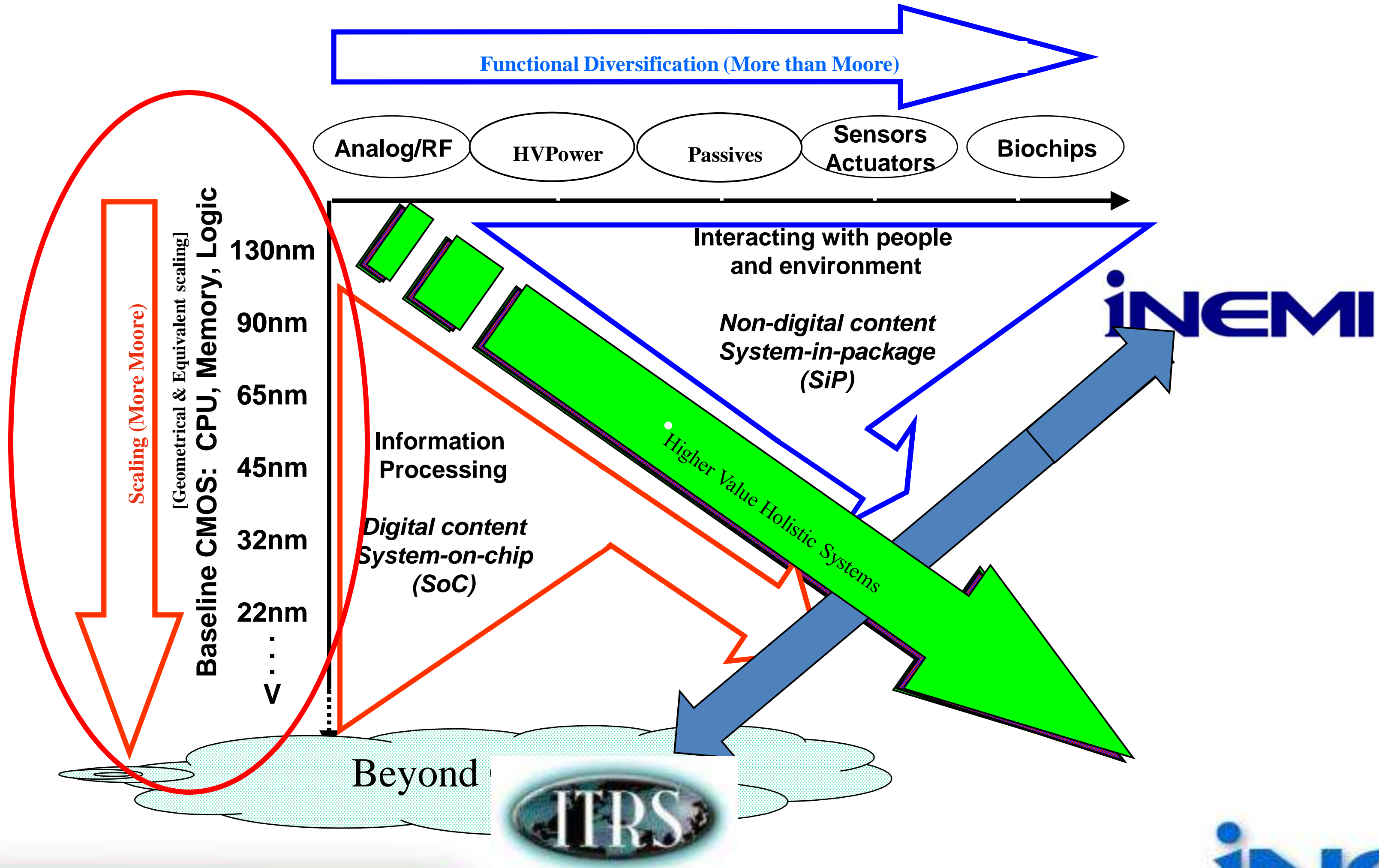
Movement from System to Chip



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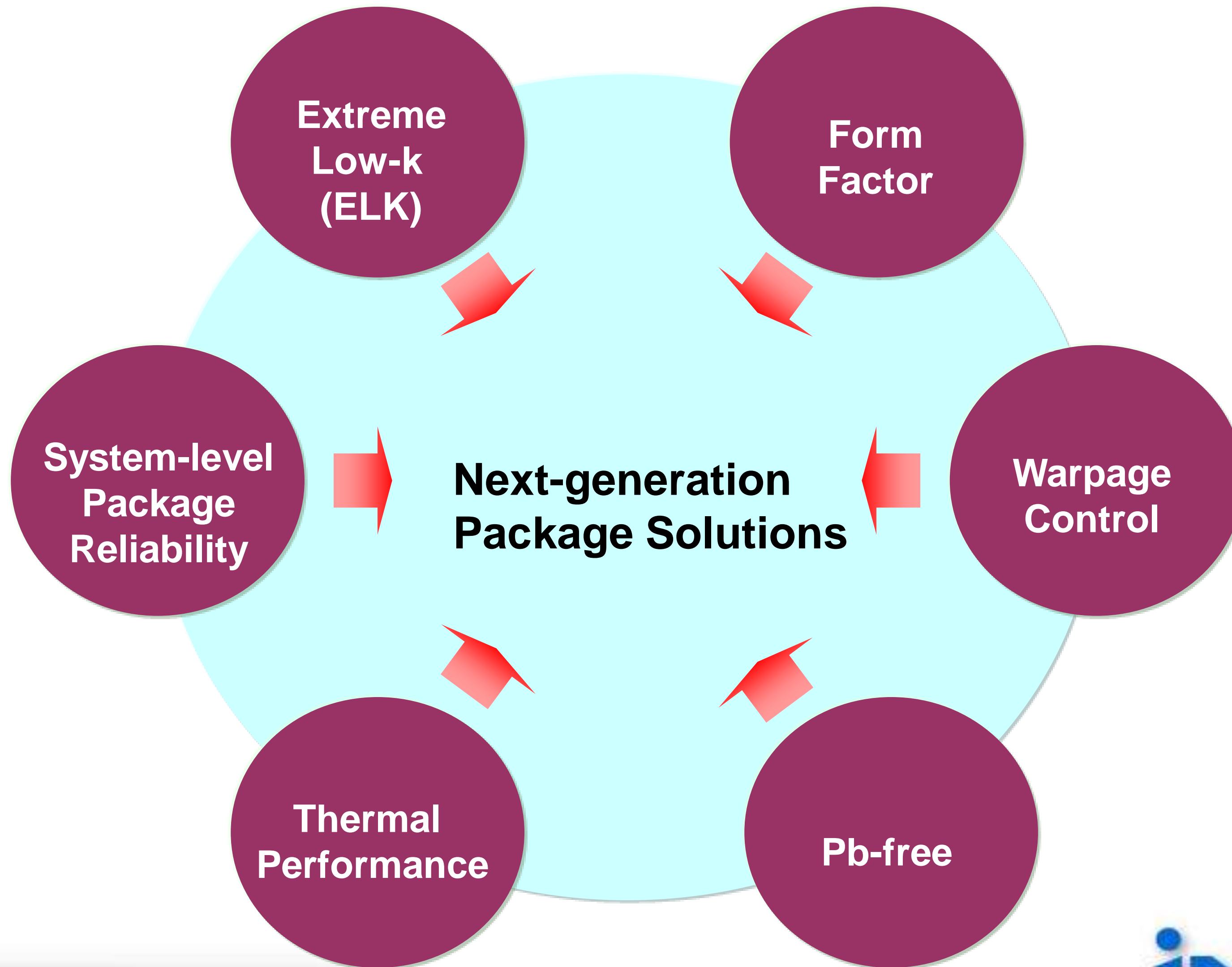
Packaging Highlights

- **Pace of Change in Packaging Technology:**
  - Accelerating to the highest rate in history
  - Driven by the penetration of electronics into virtually every segment
- **Stimulating an acceleration of innovation**
  - Achieved for both Lower Cost and Higher Performance
  - Design Concepts, Packaging architectures, Materials, Manufacturing Processes
- **New Technologies**
  - System-in-Package, Wafer Level Packaging, Wafer Thinning, Through Silicon Vias
  - Additional changes with Nano Materials
  - New wireless and mixed signal devices, bio-chips, optoelectronics, MEMS
- **Continued Increase in Functional Density**
  - With decrease in cost per function
- **Assembly by Contractors**
  - Operating in very competitive markets with low gross margin
  - Reducing their ability to invest in the new technology by revenue drop
  - Continued Market requirement to lower the cost per function

Packaging Challenges



Areas of Focus

- Materials
- Embedded components
- 3D integration
- Wafer thinning
- Interposers
- Bonding (d-d, w-w, d-w)
- Optical interconnect for SiP

Connectivity is the Key to Consumer Growth

- **GPS** – 421MM+ chipsets sold in 2008E, +57% Y/Y; Cell Phones / PDAs = 60% of GPS shipments.

- **3G** – 485MM global users, +46% Y/Y in CQ2, >11% mobile user penetration, rising to 44% by 2013E…Japan / W. Europe / USA already >30% penetration.

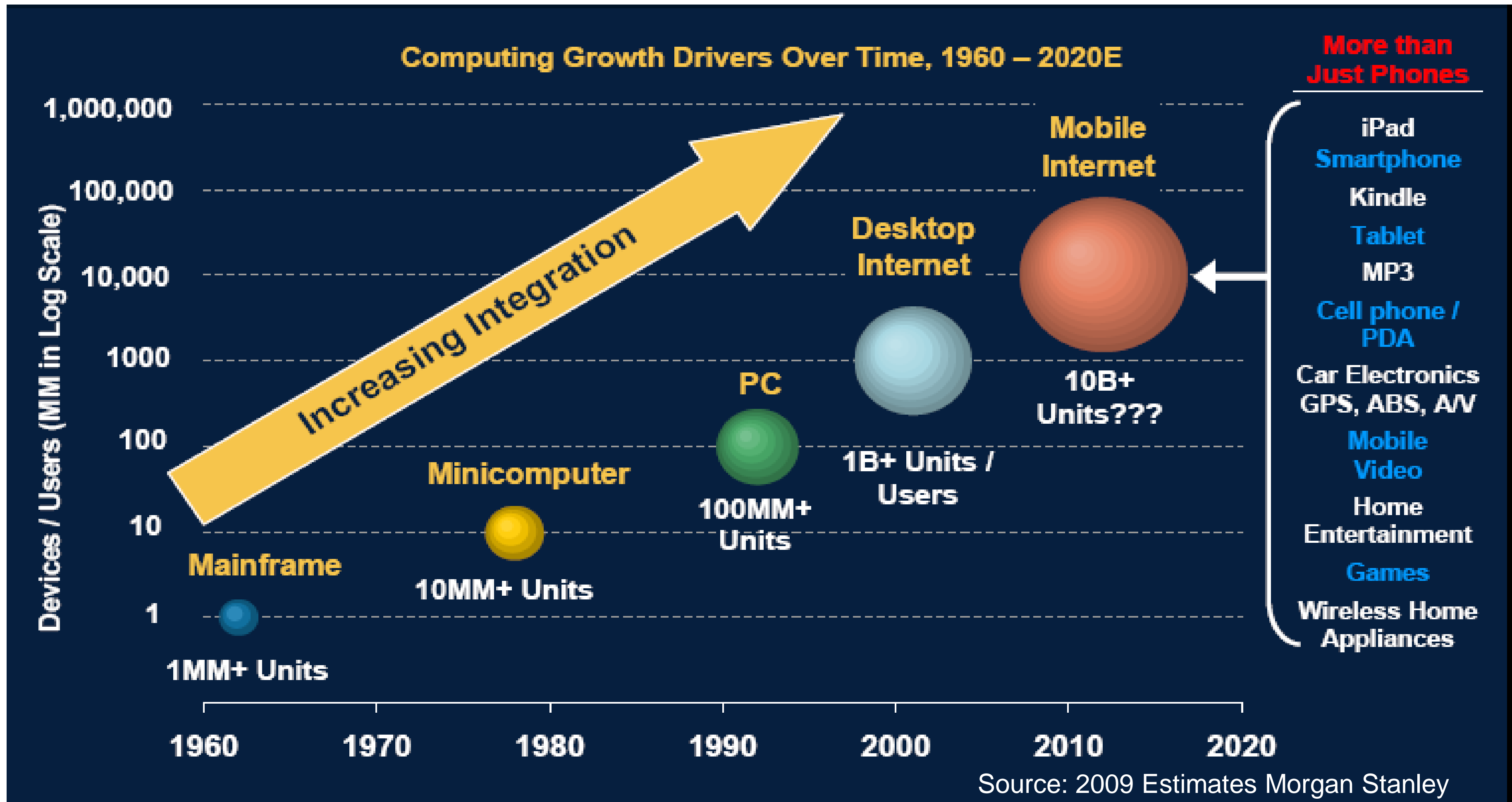
- **Wi-Fi** – 319MM chipsets sold in 2008E, +42% Y/Y with 862MM installed base; estimate 60% of iPhone / iTouch usage may be on Wi-Fi, providing a crucial (and ~10x faster) offload to stressed 3G networks.

- **Bluetooth** – 1.3B Bluetooth-enabled units shipped in 2008, +45% Y/Y; 2B+ Bluetooth devices in use.

Source: 2009 Estimates Morgan Stanley

Ease of use Improvements Drive Growth

User Interface + Smaller Form Factor + Lower Prices + New Services



The Consumer dominates the Market and The Market makes the decisions

What does the Consumer want?

- Lower cost
- Higher performance
- Longer battery life
- Innovative features
- Connectivity (wireless)
- Smaller size
- Lighter weight
- Less heat generation
- Rapid availability

Roadmap of Quantified Key Attribute Needs

Functional Diversification ("More than Moore") is driving rapid change in Packaging and Component Substrate Technology for Consumer products

New packaging technologies needed to satisfy market requirements include:

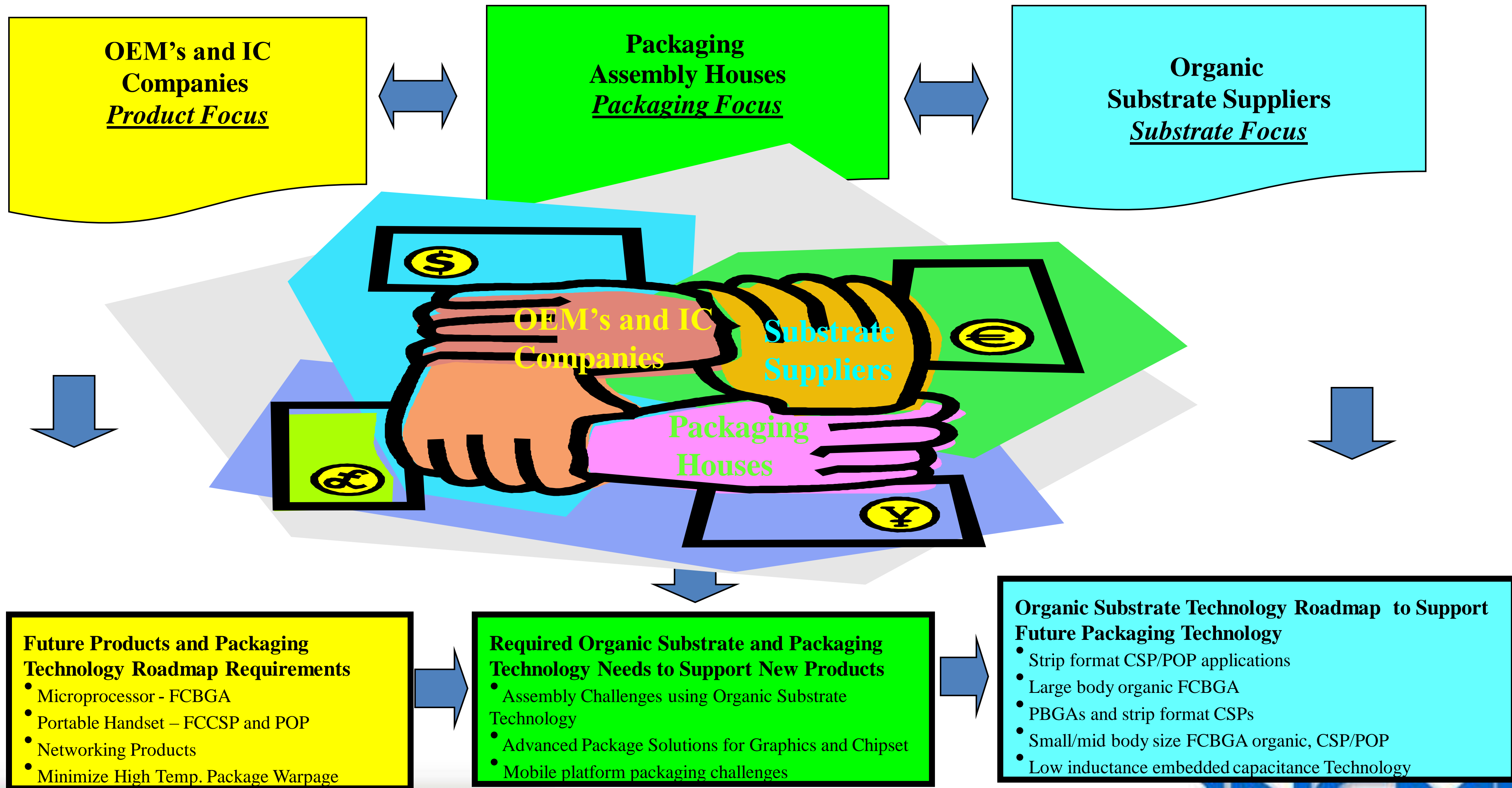
- **Wafer level packaging**
- **Wafer thinning**
- **System in Package (SiP)**
- **Printed electronics**
- **Direct bonding interconnect**
- **New conducting materials**
- **New dielectric materials**
- **3D Integration**

3D integration will require a combination of new technologies and materials including some defined above

Pushing the Envelope

- **All of these new technologies are moving very quickly.**
- **In today's world the effectiveness of an integrated supply chain approach is key**
- **Multiple nodes on the supply chain covering all aspects of design, materials, assembly, test, etc, etc**
- **Cooperative roadmap efforts of groups (such as, MIG, iNEMI, IPC, TPCA and ITRS) are key to clarify timing and needs**
- **There are many/many opportunities for collaborative R&D**
  - An iNEMI Strength and Core Capability

R&D Pre-Competitive Collaboration Model



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Next Steps

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The Next iNEMI Deliverables Are Key: Addressing the Gaps

- **The next key deliverables**
  - 2011 Technical Plan (available only to members August 2011)
  - 2011 Research Priorities (available at www.inemi.org August 2011)
- **Effective usage and coordination behind both these documents will be key to continued industry progress and growth**
- **2011 iNEMI Roadmap Availability**
  - The 2011 iNEMI Roadmap CD is available for order at www.inemi.org
  - Individual roadmap chapters are also available as a PDF document at www.inemi.org
- **2013 iNEMI Roadmap Development Cycle**
  - Formal start is October 21st, 2011 here at SMTAI – Q&A session in room 200 at 4:00PM today for anyone interested in participating
  - Please contact Chuck Richardson for opportunities to participate
  - Not a requirement to be an iNEMI member

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