Embedded System Education in Taiwan: Past and Future

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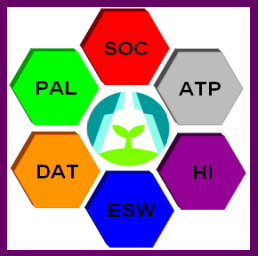
National Chiao Tung University

Outline

- VLSI Circuit and Systems/SoC Education Program in Taiwan (2000-2010)
- Intelligent Electronics Education Program in Taiwan (2011-2016)
- Embedded System Education Program (2003-2010)
- 4C Electronics (4C) Education Program (2011-2016)

VLSI Circuit and Systems/SoC Education Program in Taiwan (2000-2010)

中華民國 精彩一百
百年樹人 智慧傳承



Ministry of Education

National Program for Promoting Education in Advanced SoC Design

2006/1/1 ~ 2000/12/31

total budget： 1,033,012,000 NT$

Program objectives

1. To cultivate college students with advanced skills in SoC fields

- plan and develop advanced courses, lab modules
- organize short-term training workshop, summer schools, and teaching forum
- held various students competition to encourage

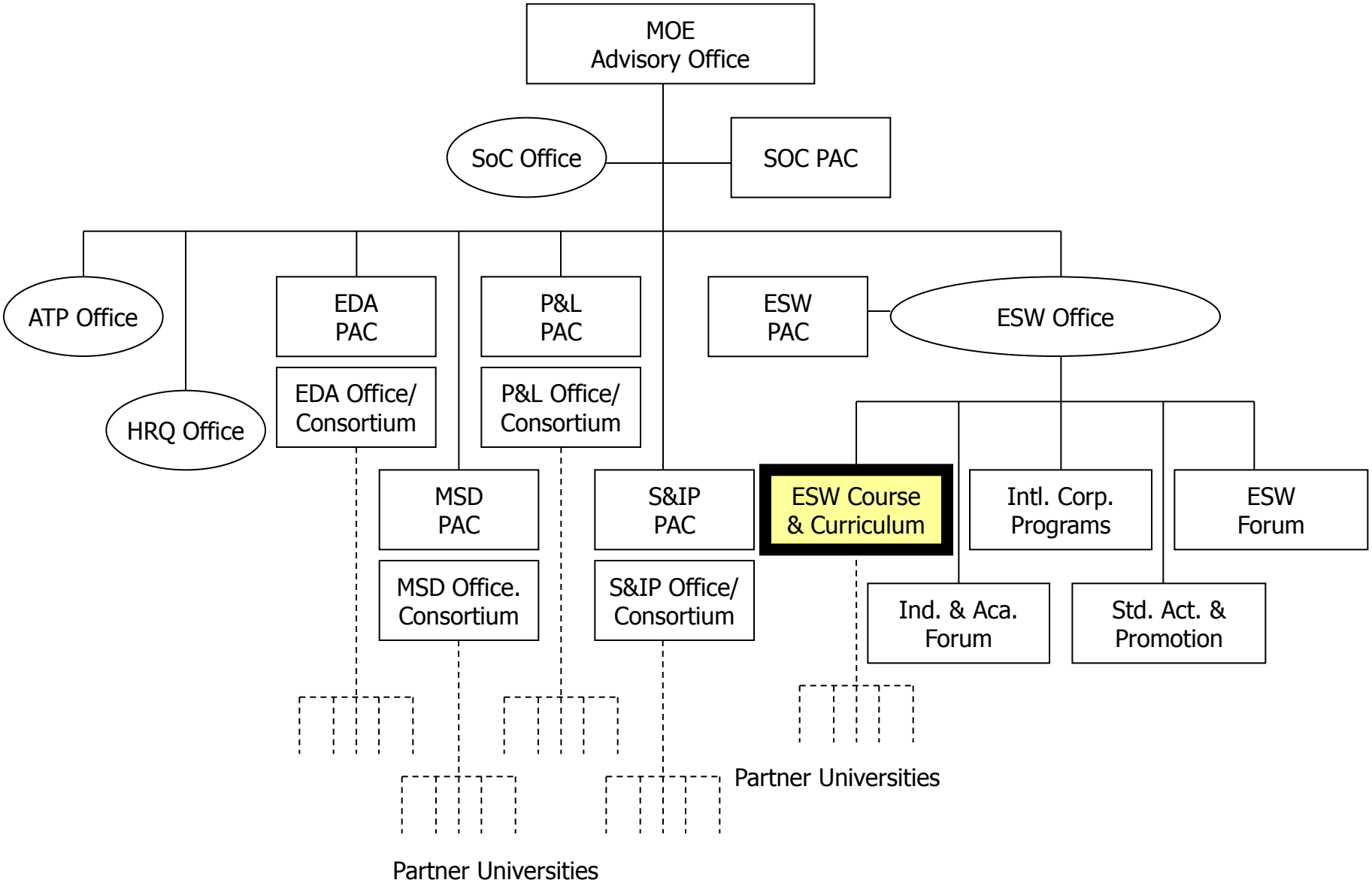
2. To improve students' competence in international activities

- Encourage participation in various international forum and workshop
- Reward students who can enter the final list of international competition
- Support professors to publish textbooks in English

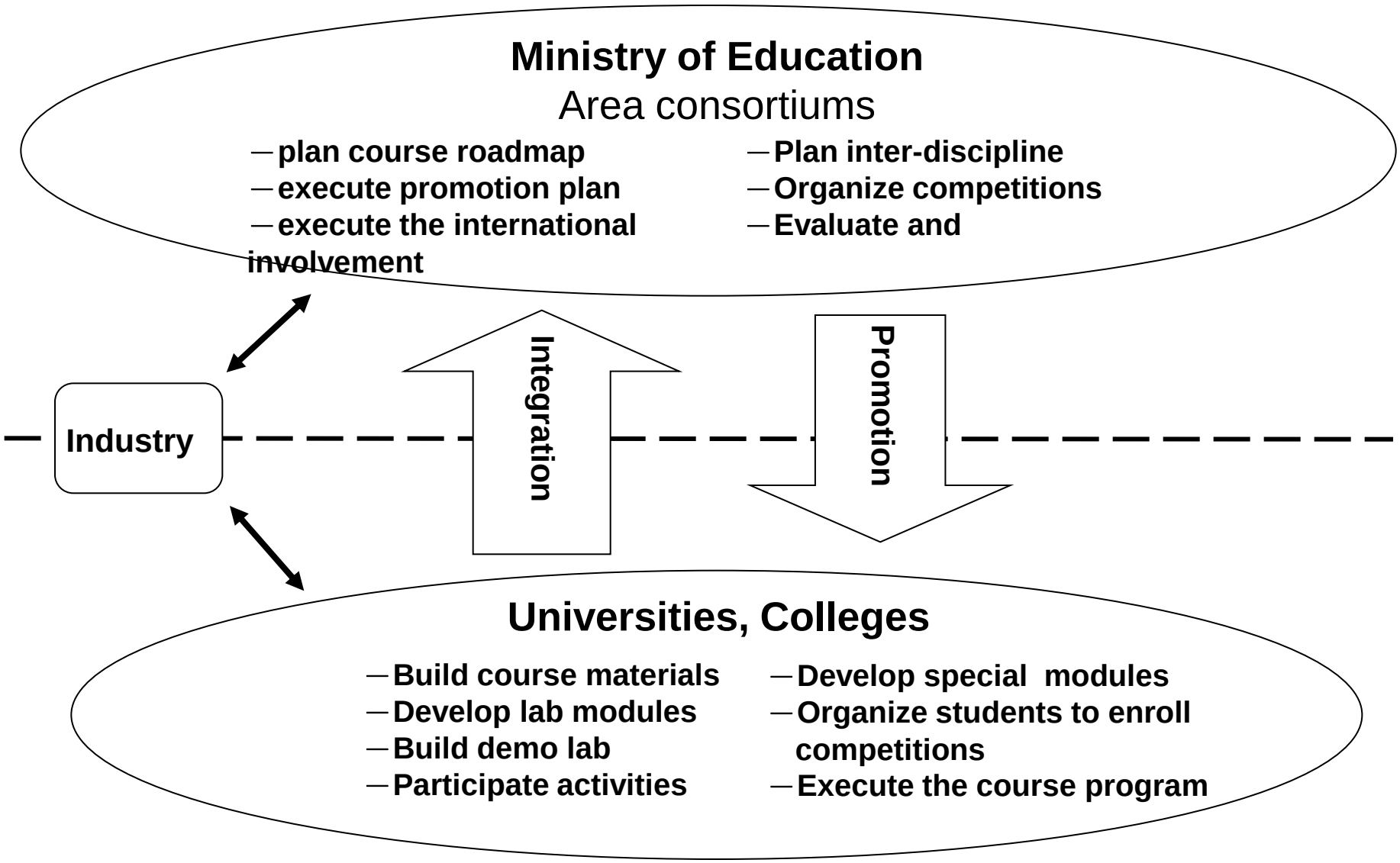
3. To develop the core capability in system integration

- Working with heterogeneous system integration, particularly aims to develop core capability across multiple disciplines

National Program for Promoting Education in Advanced SoC Design

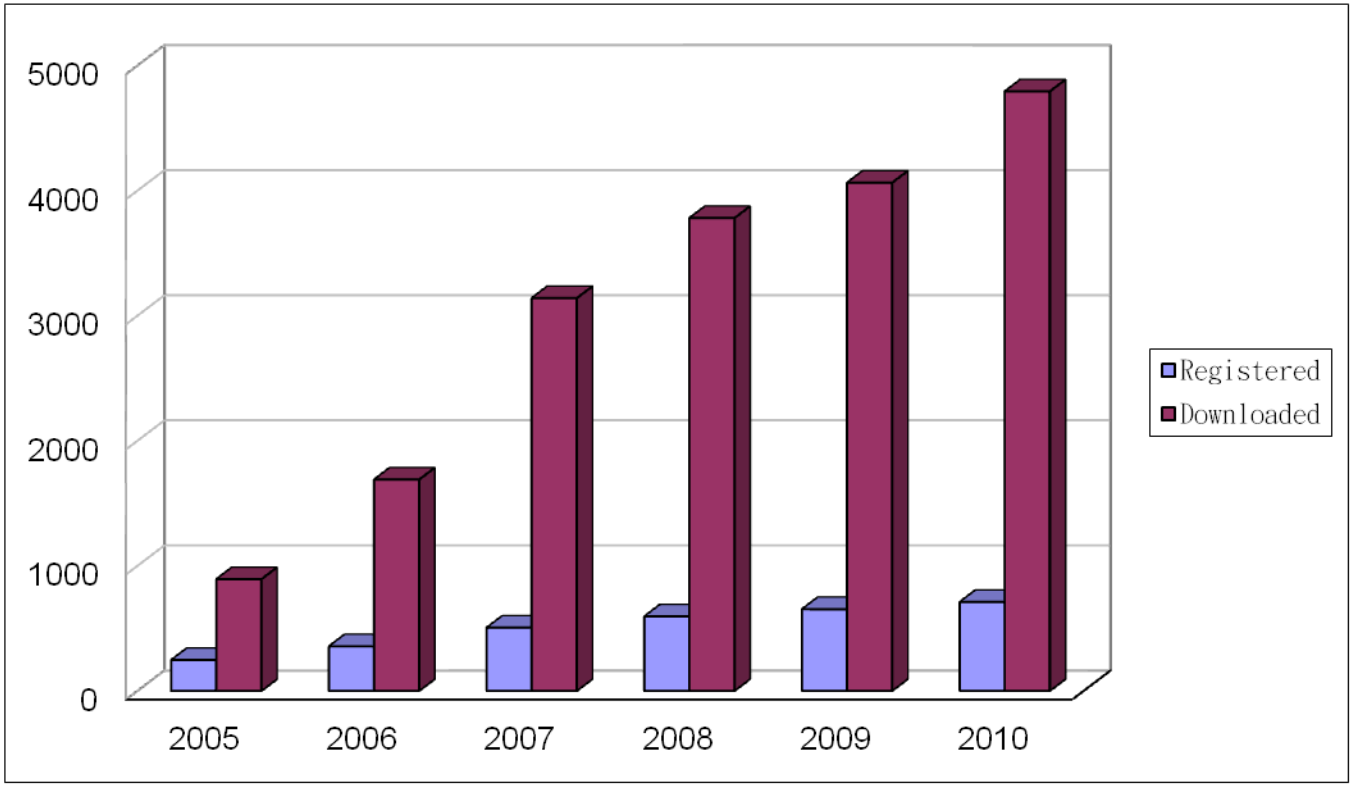


Execution Strategies

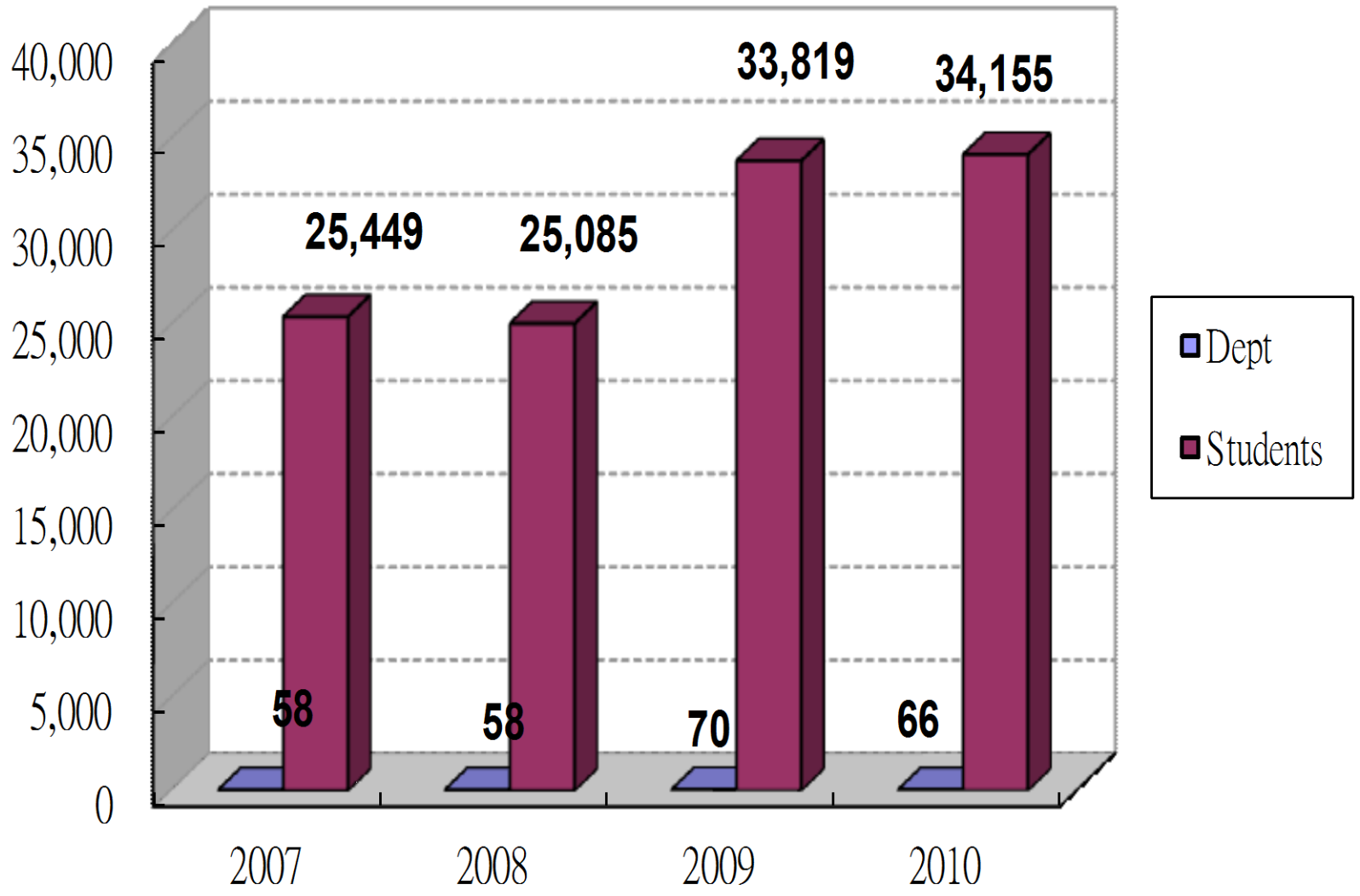


A centralized site for course materials

- So far, we collect 106 course materials and 35 lab modules
- Currently 710 users registered and 4,793 downloads



Course promotion and deployment



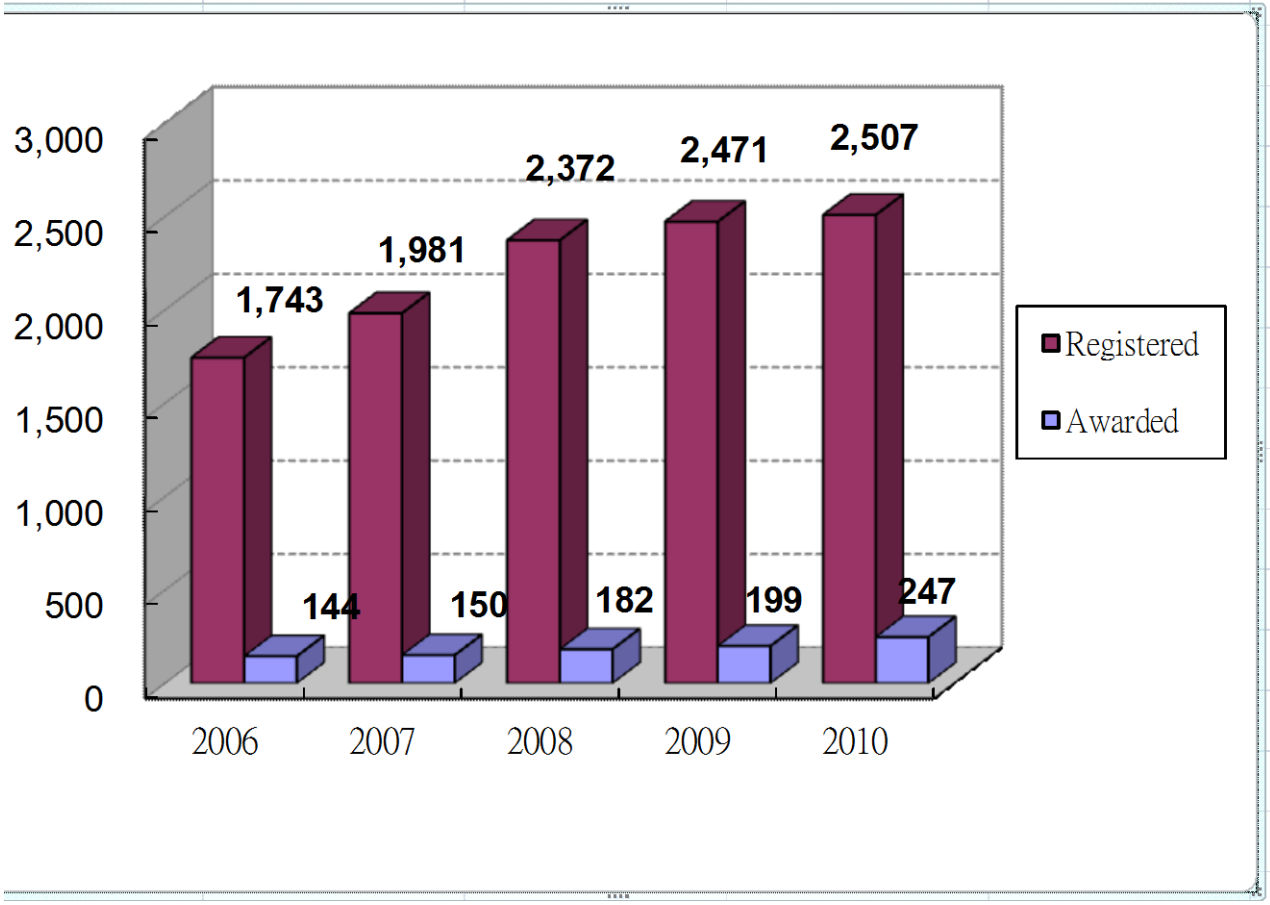
Additional activities

1. Each area consortium performed on-site reviews and visited totally 127 departments in all of the universities.
   - Each review not only evaluated the program results in terms of teaching quality, student learning, and final projects,
   - but also collected many interesting and valuable user experiences for those course roadmap.
2. Develop a across-field course—”Advanced Patent Search and Application” to attract more attentions in patent search and acquirements. The course attract more than 1800 students each year.
3. Develop—”Embedded System Product Design” to train students hands-on experiences by learning:
   - Create innovative ideas,
   - Develop product and real implementation
   - Prepare business plan for the promotion

Student competition

Organize domestic competitions

- **CAD competition**
- **Embedded System(ESW)**
- **IC design contest**



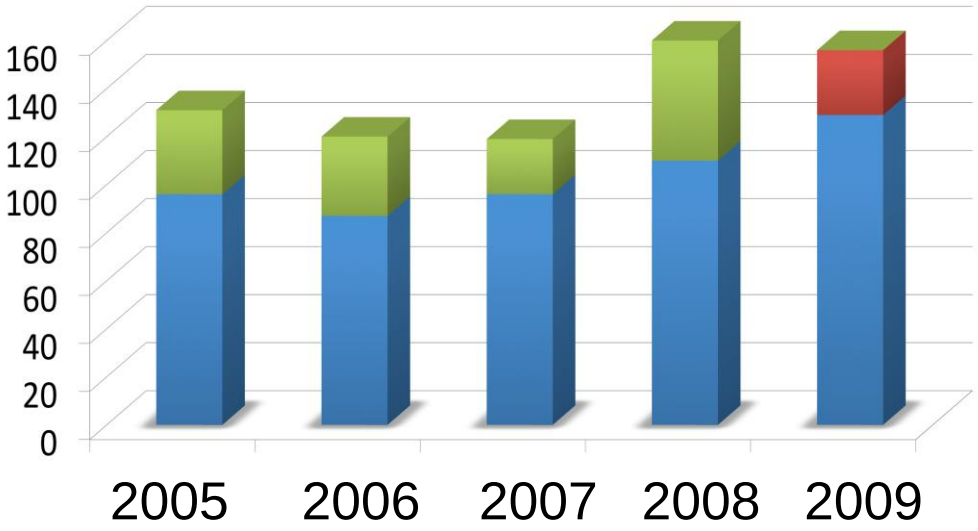
Student competition - CAD

Computer Aided Design in integrated circuit

1. A competition combining software and hardware knowledge
2. Question sets are announced 6months before the contest
3. Competition is based two categories: open topics and given-questions. Fixed questions are given by domestic major companies in electronics design automation.
4. The winners are subsided to participate international conferences and design contests.
5. Taiwan students won 『Internatioanl ACM SIGDA CADathlon at ICCAD design contests』 1st place: twice, 2nd place: twice, and the 4th place

Student competition - CAD

Number of teams enrolled in 2005~2009



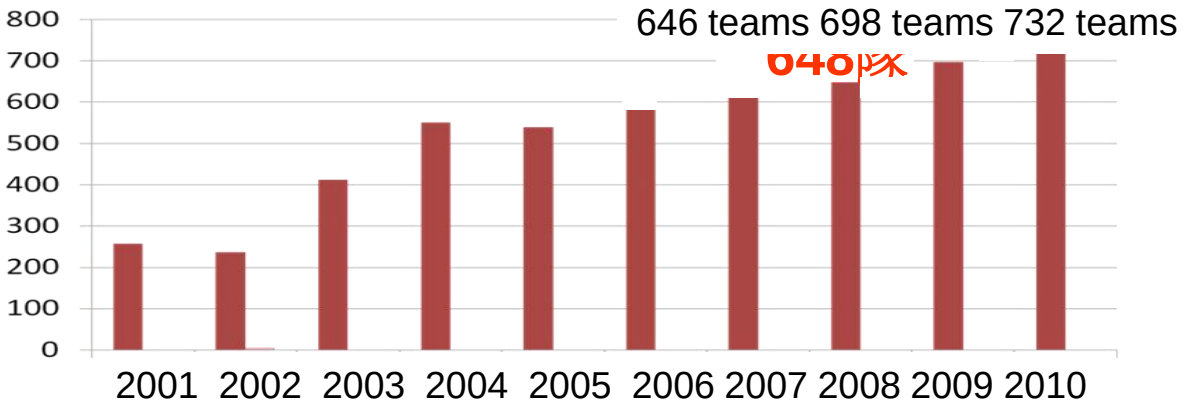
Competition site

Referee meeting

IC Design Contest

1. Supported by CIC (NSC chip implementation center)
2. Students have to go through a complete design flow from RTL design, logic synthesis, layout, and place&route.
3. Design contest is organized in one day from 8:30am until 20:30pm.
4. The contest includes 5~7 categories: college layout design, analog circuit design, full-custom IC design, cell-based IC design, and FPGA.

Total 1464 students participation



IC design competition

Embedded system competition

1.A system design contest emphasizes on software and hardware integration:

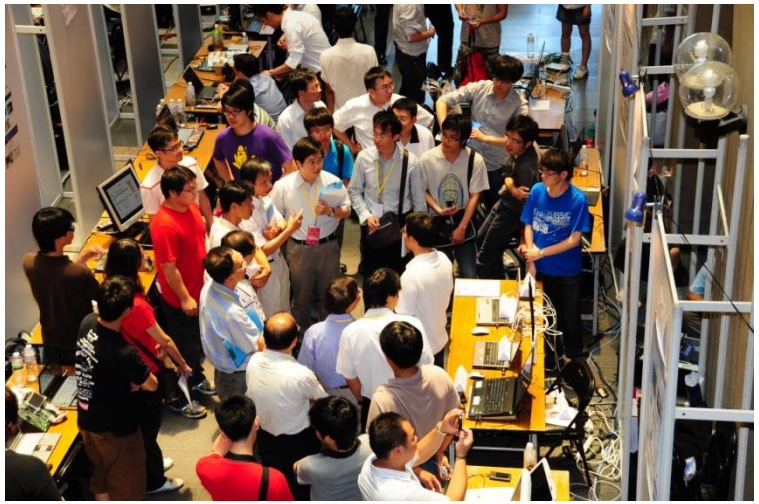
- Embedded system software
- Open-source design
- Innovative embedded system
- HW/SW integration

2.The contest is open to public for the whole day. Students exchange their experience and learn from others.

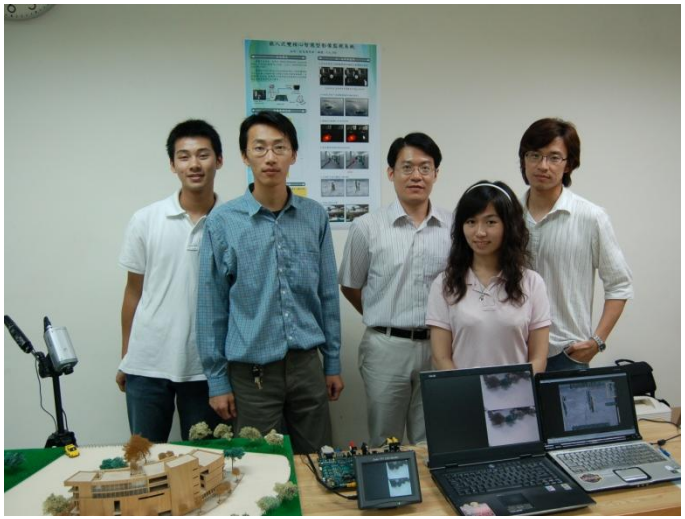
3.Several board platforms are provided by domestic companies and system industry.

2005	2006	2007	2008	2009	2010
98 teams	127 teams	201 teams	213 teams	283 teams	261 teams

Embedded system competition



Embedded system competition



Domestic Academic Activities

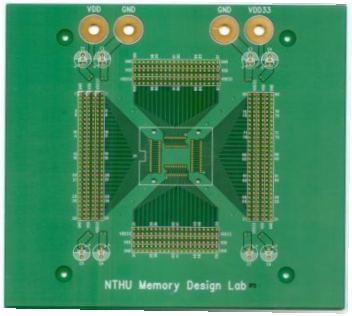
Activities	# of	# of participants
Local workshop	48	9,231
Seed teacher training	29	1,541
Technical forum	146	5,294
Student training	23	1,809
Industrial forum	47	2,361
Course announcement	22	2,133
Area Consortium meetings	13	2,236
Total	328	24,605

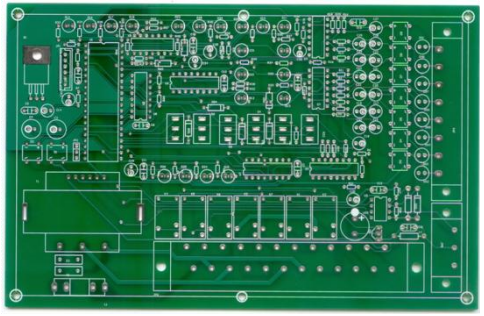
Contributions to International Conferences

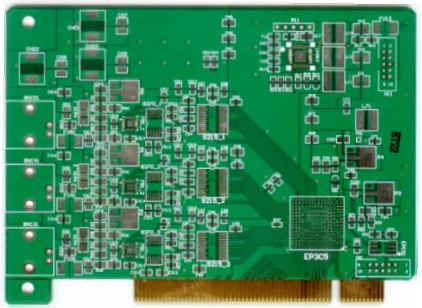
	2006	2007	2008	2009	2010
ICCAD	10	15	11	17	18
DAC	8	12	12	15	15
ITC	5	2	3	3	2
Total	23	29	26	35	35

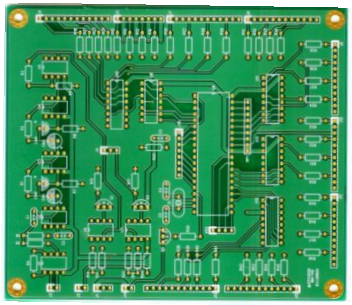
PCB design and service

Service promotion workshop	High speed PCB workshop	Training the trainer	workshop	proposal	PCB board
12	3	2	3	18	138









Summary

- National-wide teaching quality in IC and SoC design is significantly improved. More students are attracted to join this area.
- More advanced designs are carried out and more papers are accepted in prestigious conferences.
- More collaborations are enabled among academic universities, research institutes, and the industry.
- Attract many international visits to learn the successful story

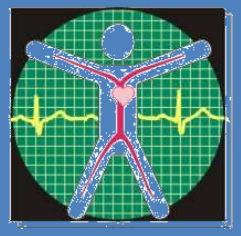
Intelligent Electronics Education Program in Taiwan (2011-2016)

2011/4/1 ~ 2016/12/31

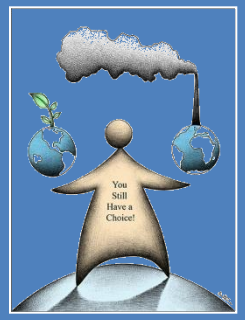
total budget： 1,000,000,000 NT$

National Program of Intelligent Electronic

High value-added Solutions for MG+4C



Medical



Green

Car

3C

Intelligent Electronics Education Program

MOE | **MOEA** | **NSC** | **MOH**

Advanced Industry technology

Intelligent Electronics Education Program

中華民國 精彩一百

百年樹人 智慧傳承

Cultivate advanced capability in system integration

Consolidate in-depth skills

More international involvement

Encourage multi-discipline (course, lab modules, intern etc)

Develop advanced courses

Increase international visibility

Student training

Teacher capability

Innovative System design

Advanced courses (3D IC、….)

Core courses

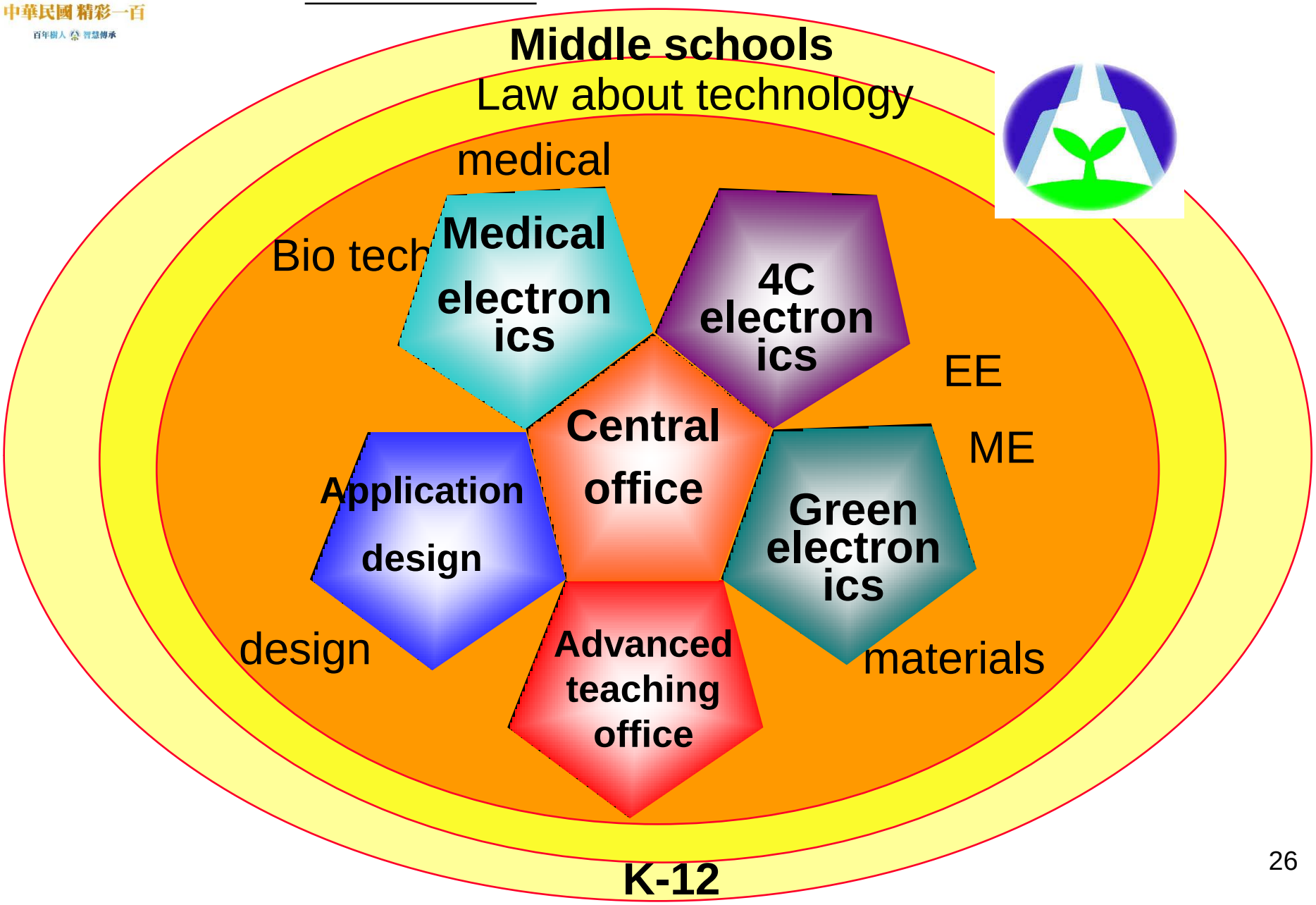
Basic courses

International activities

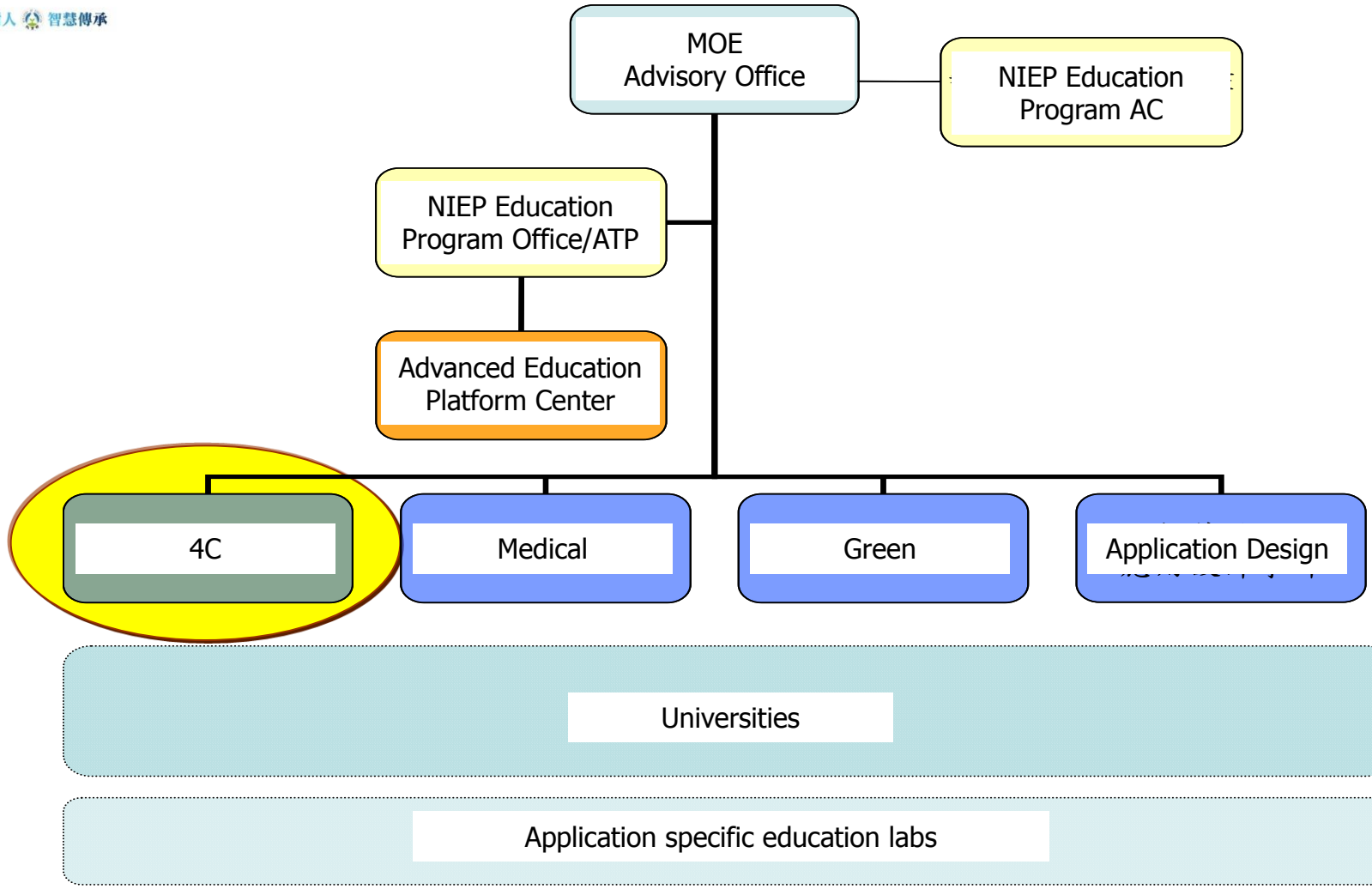
VLSI/SoC projects/plan

K12 students and teacher

Targets


Middle schools
Law about technology
medical
Bio tech
Medical electron ics
4C electron ics
EE
ME
Central office
Application design
Green electron ics
design
materials
Advanced teaching office
K-12

Program Organization

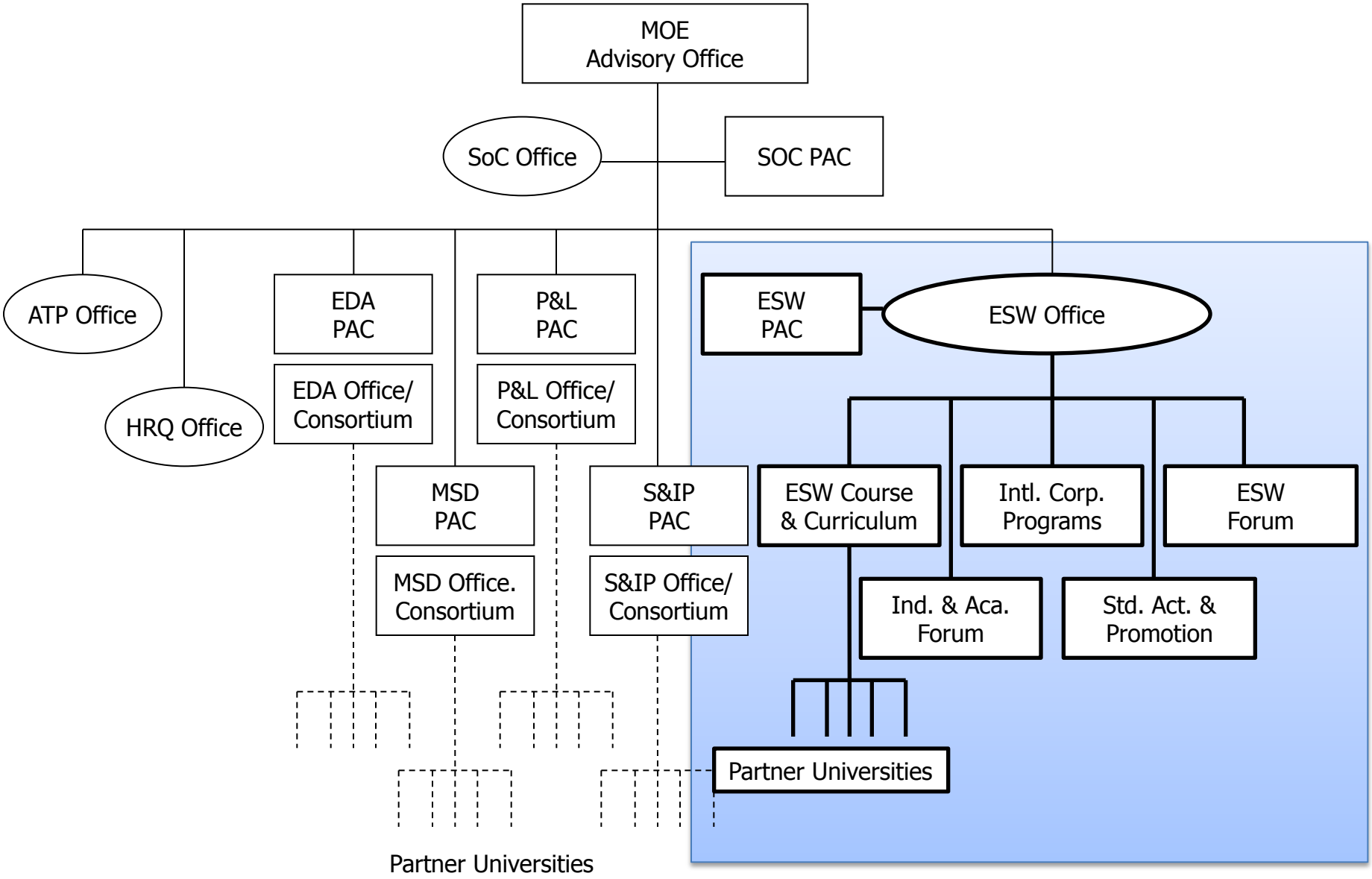


Embedded System Education Program (2004-2010)

Previous SoC and Embedded System Education Promotion Program (2004-2010)

- Embedded System Consortium
  - The last (but not least) consortium founded by the MOE under the VLSI/SoC CSE Program
  - Address the challenges of embedded software development for SoC systems
  - Chairs of Embedded System Consortium
    - Prof. Youn-Long Steve Lin, 2004-2006
    - Prof. Chung-Ta King, 2006-2008
    - Prof. Jenq-Kuen Lee, 2008-2010

MOE/VLSI Program/ESW Consortium

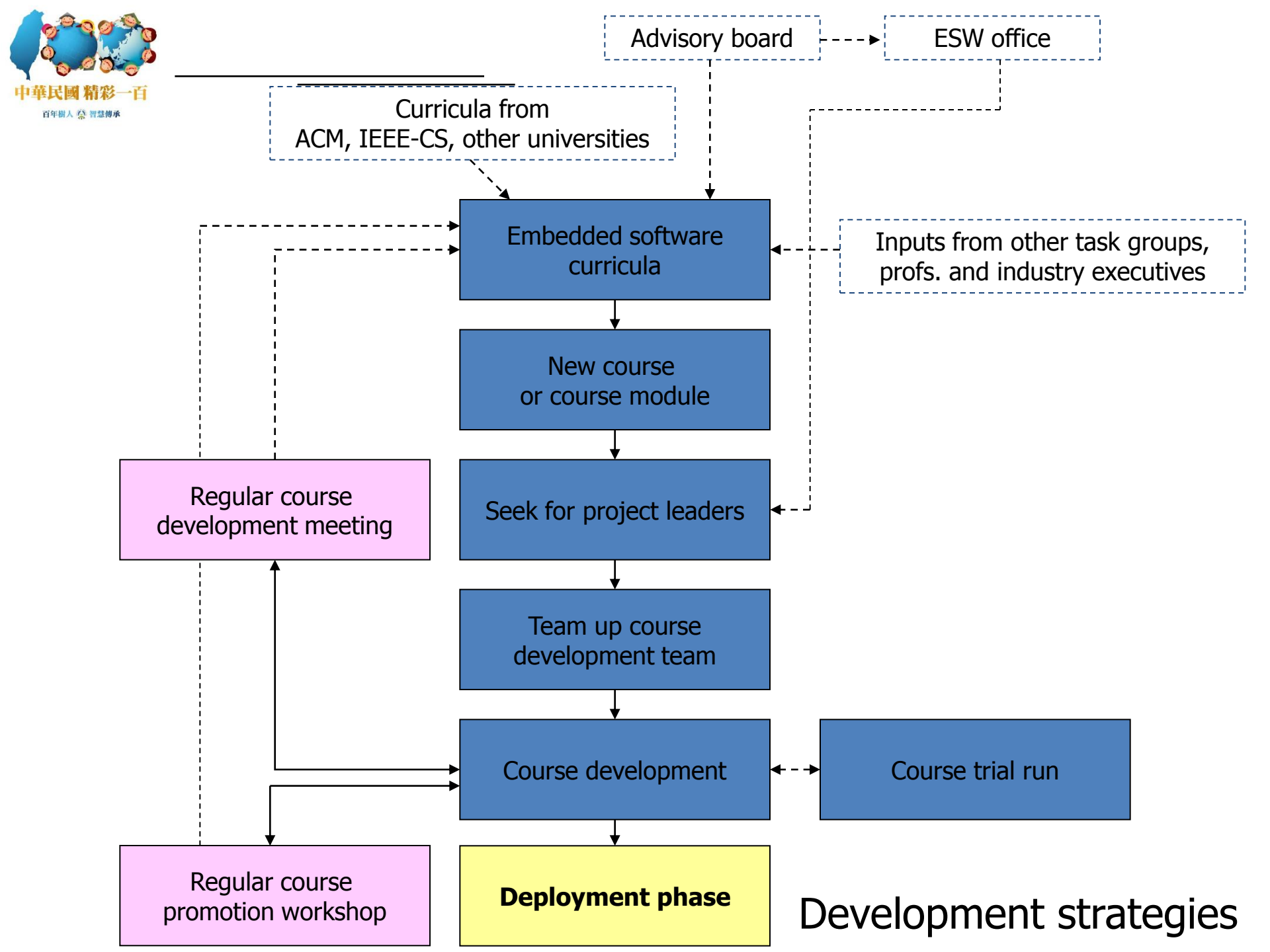


ESW Consortium Activities

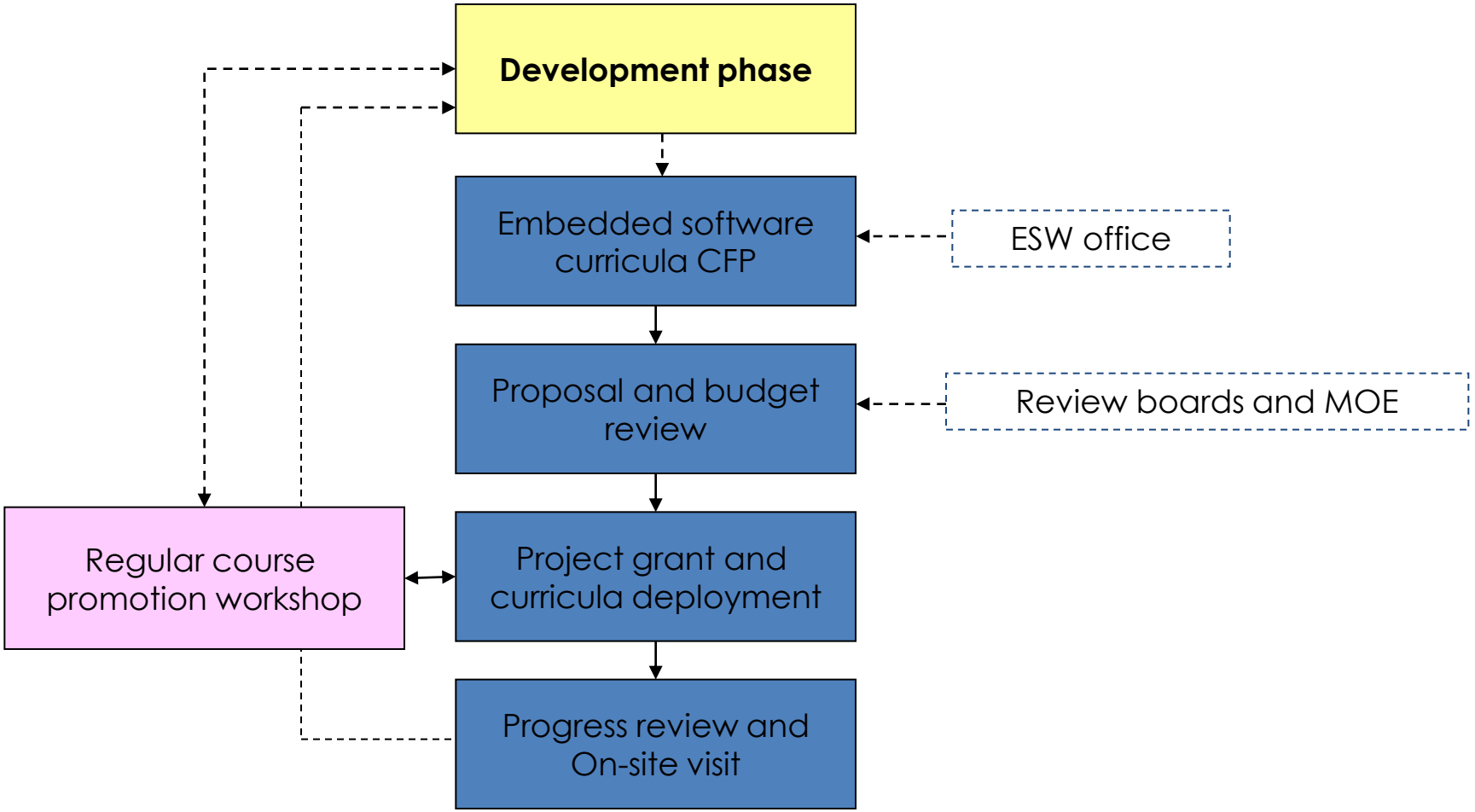
- Technical forum
  - 9 workshops/1328 attendees/2006-2010
- Training the trainer workshop
  - 18 workshops/1142 profs/TAs/2006-2010
- Summer camp
  - 100 undergraduates/2008, 2010
- International forum
  - 8 workshops/1158 attendees/2006-2010
- Industrial forum
  - 12 workshops/838 attends/2006-2010

ESW Consortium Activities

- ESW Curriculum
- Develop reference ESW curricula for universities
  - Develop or enhance courseware including Labs for ESW courses
  - Promote ESW curricula for CS/EE depts



Development strategies



Deployment strategies

Embedded software curricula

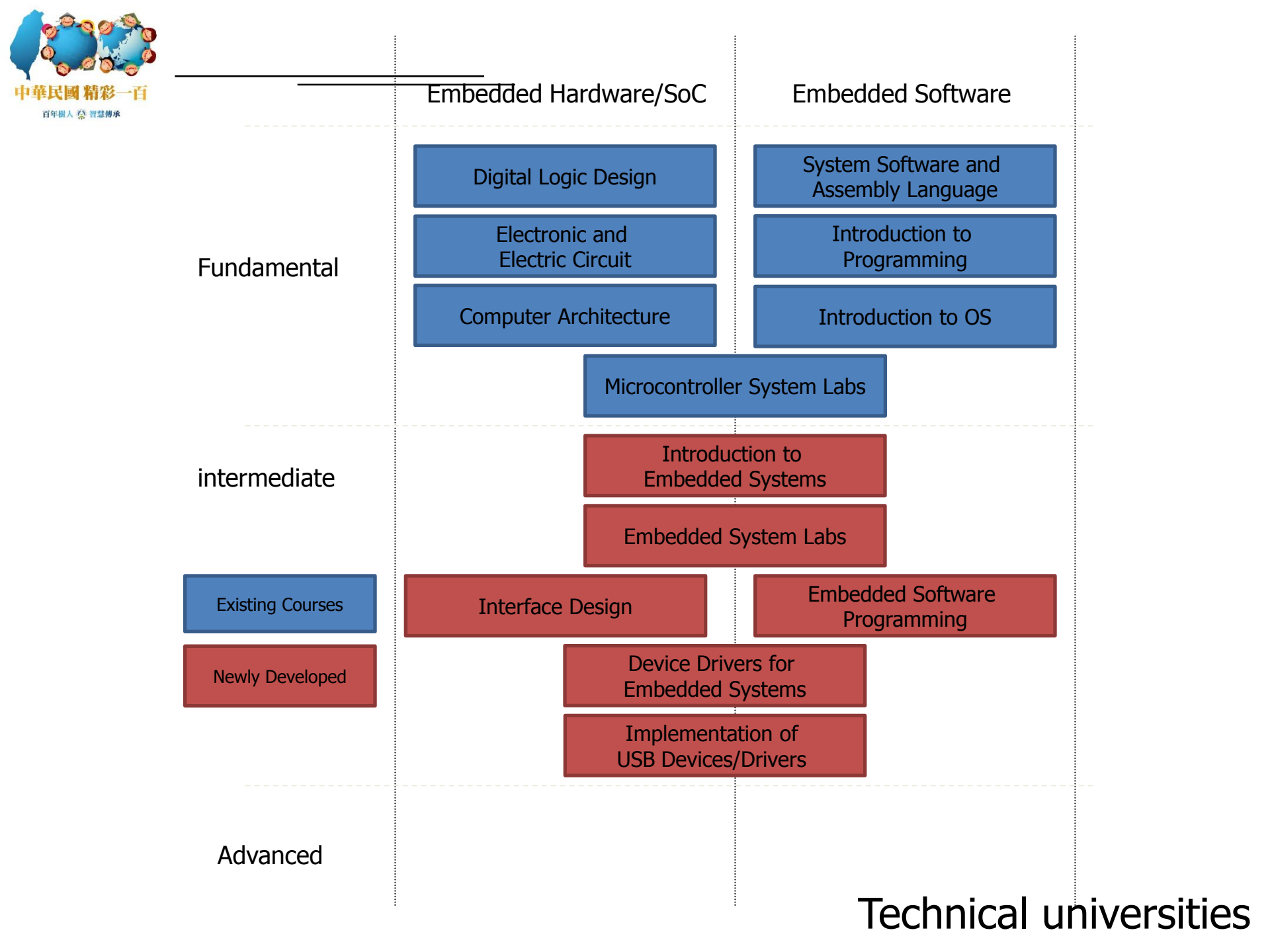
- Universities
  - train students with research, design and development abilities
- Technical universities
  - offer trainings to students with technical skills and implementation abilities

	Embedded Hardware/SoC	Embedded System Software	Embedded Application Software
Fundamental	Digital Logic Design	System Software	Programming Language
	Electronic and Electric Circuit		Introduction to DSP
intermediate	Computer Organization	Introduction to OS	Embedded Software Programming
		Advanced System Software	
	Microprocessor Lab.	Embedded Tool chians	DSP Labs
	HDL & FPGA	Advanced OS	
Advanced	Embedded System Design		
	Embedded System and Software Engineering		
	SOC Design	Implementation of Embedded OS	Embedded Java Programming
	Heterogeneous multi-core	Embedded Real Time Systems	Embedded Middleware
	HW/SW Co-Design	Embedded Compiler Design	ESW for Networked SoCs
	Embedded Processor	I/O and Device Drivers	Special Projects for Embedded Mobile Systems
	SOC Labs		Special Projects for Embedded Sensors
	Embedded Multi-core and Software		Special Projects for Embedded Multimedia Systems
			Embedded Multi-core Programming

Existing Courses

Newly Developed

Universities



Technical universities

Results and experiences

- 17 courses/8 modules/2684 students enrolled
- Course development projects
  - about total USD 50,000-100,000 for the course development
  - total USD 15,000 per year for maintenance
- 71 professors from more than 26 universities involve the course development
  - 40% professors are from EE and related departments
  - 60% professors are from the CS department

Results and experiences

- Each course development project
  - 200-500 slides/notes
  - Some projects published textbooks
  - 4-15 hands-on labs/TA-notes
- Number of courseware download
  - 2371 download (2007-2010)

Results and experiences (Cont.)

- Curricula promotion workshops every year
  - more than 800 attendees including professors, students, and engineers from industries

- Received >200 proposals and approved >140 proposals from 2005-2010
  - About USD 10,000 to 100,000 is funded for the first year

Results and experiences (Cont.)

- ESW education infrastructures have been established in more than 30 universities
  - > 2000 students enrolled these courses under the ESW curricula deployment program

Results and experiences (Cont.)

- Challenges and issues
  - the common education platform
    - to develop different sets of hands-on labs over various platforms
    - require all hands-on labs to be developed over one or two common hardware platforms
  - the development of hands-on labs
    - TA notes, reference source codes or reports, and knowledge and experiences learned from the labs are extremely important

Results and experiences (Cont.)

- **Establish a database for hands-on labs**
  - Lab road map
  - >100 labs
  - peer review

Embedded System Design Contest

	2006	2007	2008	2009	2010	合計
Students	159	127	527	508	562	1883
Team	53	59	143	221	216	692
Awarded students	45	45	67	95	90	342
Awarded team	15	16	25	35	33	124

Microsoft Imagine Cup 2010, 2011 Embedded System Champions

Microsoft Reveals Imagine Cup 2011 Winners, Unveils $3 Million Gran... http://www.microsoft.com/Presspass/press/2011/jul11/07-13IC

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Reveals Imagine Cup 2011 Winners,
3 Million Grant Program

ning student projects hail from Bangladesh, Brazil, Denmark, France, Greece, Poland, Romania and Taiwan.

101 96 Share 31 Email

July 13, 2011 — Microsoft Corp. today announced the winners of the ninth annual Microsoft Imagine Cup, the world's premier student technology competition, honoring student innovations that address global problems such as improving road and fire safety, eradicating poverty, and creating a more sustainable environment. The company also unveiled plans to launch a three-year, $3 million competitive grant program to help recipients realize their vision of solving the world's toughest problems.

"The innovators, entrepreneurs and humanitarians who compete in the Imagine Cup have developed an inspiring spectrum of projects, raising the bar higher and higher each year," said S. Somasegar, senior vice president, Developer Division, Microsoft. "We are in awe of the students' solutions for addressing social and real-world challenges, and want to help them take their projects to the next level with the financial, technical and business support they need to change the world."

Imagine Cup 2011 Award Highlights

Image 4 of 8

NTHUCS

Taiwan's Team NTHUCS sets up their display booth at the Imagine Cup 2011 Worldwide Finals. The team won the Embedded Development contest with project RIGHT!! This Way, which computes the safest fire escape routes in real time as detected by a wireless sensor network.

Web-Ready

Print-Ready

Imagine Cup teams will be eligible to apply for grants that include a combination of cash, software,

Press Resources

Contact

Rapid Response Team
Waggener Edstrom Worldwide
(503) 443-7070

Related Items

Feature Stories:

Dream Chasers: Winners 2011 Imagine Cup Announced in New York C
July 13, 2011

Microsoft Resources

Imagine Cup 2011 Websit

Imagine Cup Newsroom

Key working items in new education program

- A common teaching platform
- Construct a complete Lab database
- Need top-down (system-view) curriculum design

4C Electronics (4C) Education Program (2011-2016)

Basics of 4C Electronics (4C) Education Consortium

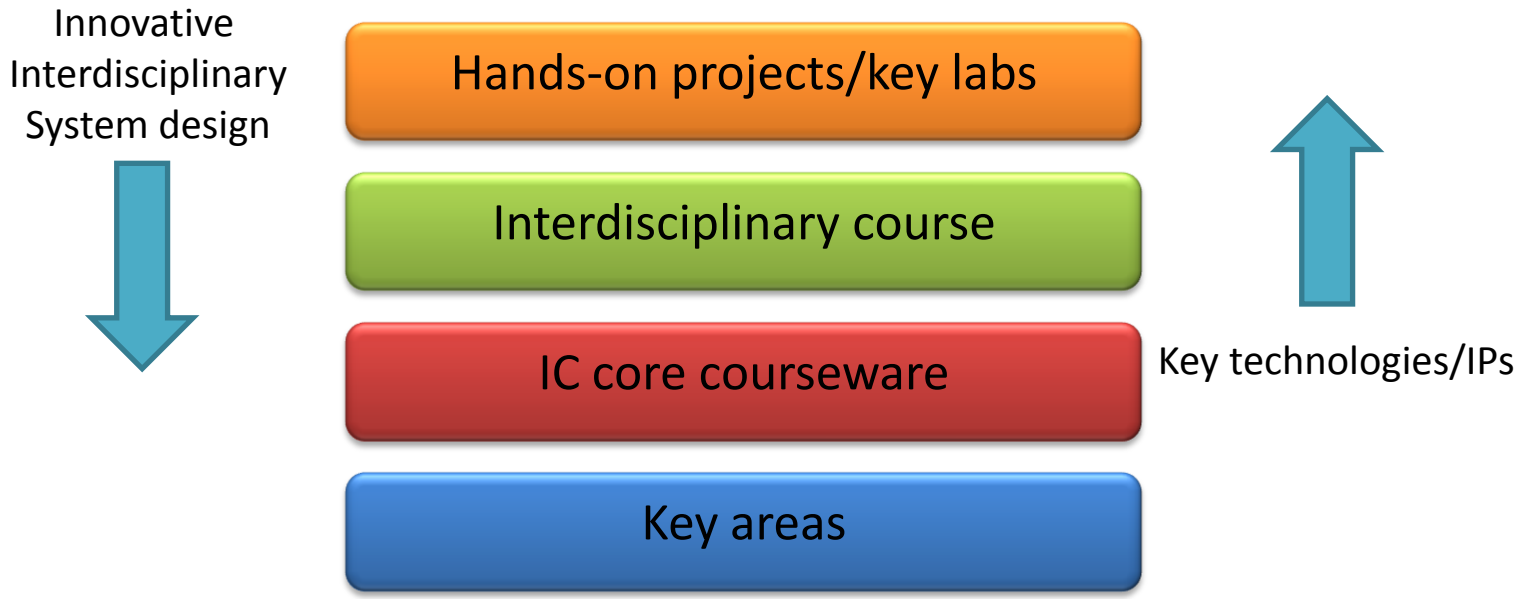
- Sponsored by Ministry of Education
- Chair of 4C electronics
  - Prof. Tien-Fu Chen
- Project period from 2011 to 2016
  - 1st stage 2011 to 2014
- Budget
  - Curriculum/education key lab development: USD 500,000/year
  - Curriculum/education key lab promotion: > USD 1,000,000/year
- >15 universities/30 profs. involved

Objectives

- Promote 4C Electronics (4C) education in Taiwan
- Top-down: train EE/CS talents with system-level design views
- Bottom-up: identify key technologies/IPs in future 4C IC/IT products

Approaches

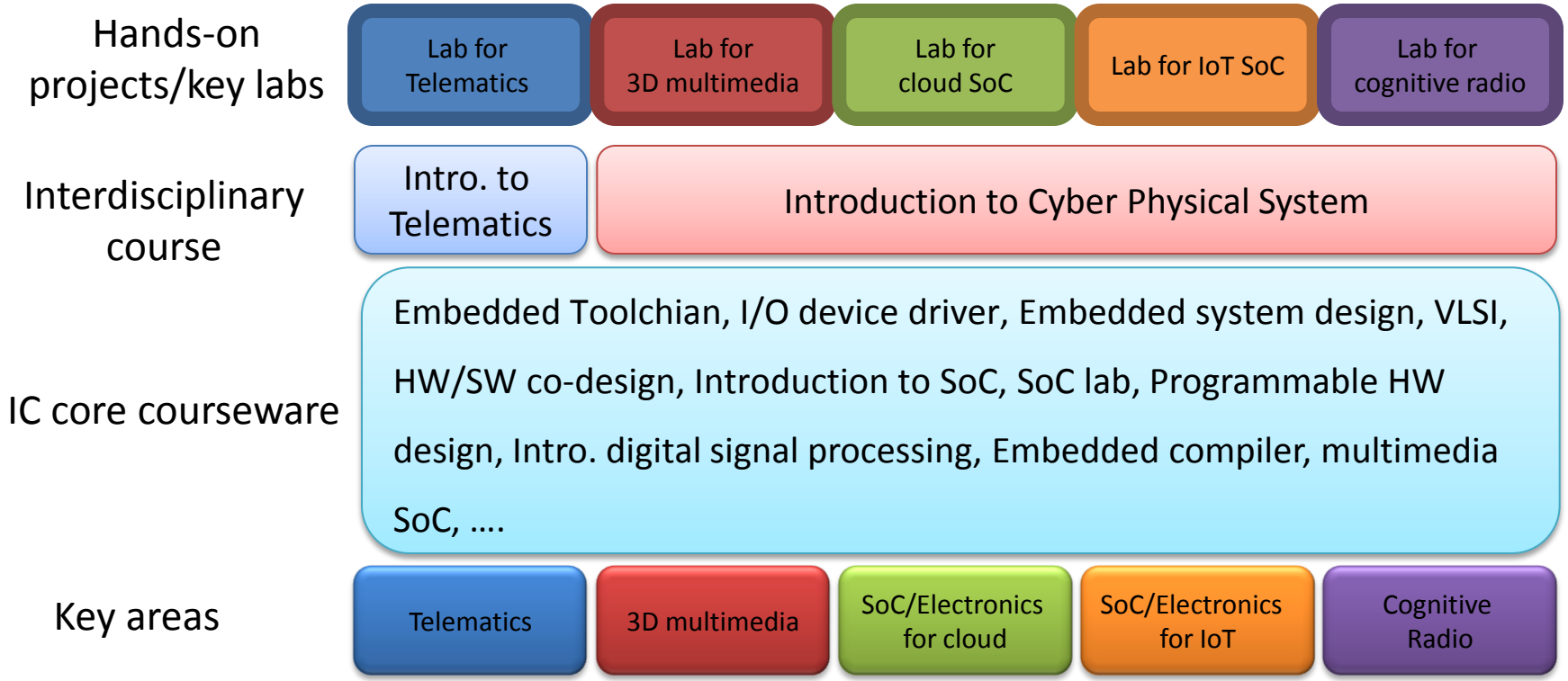
- Develop and promote curriculum and lab in 4C key areas
  - Interdisciplinary/System/applications/common education platform



Approaches

- Identify 5 important 4C key areas (application specific, top-down system view)
- Propose curriculum for each key area (based on what we have developed during past 10 years)
- Design an interdisciplinary course for each key area
- Design a common education platform for each key area (can be used in all courses in each key area)
- Design an application-specific hands-on course for each key area
- Help university to establish the education lab in key area

Curriculum and labs



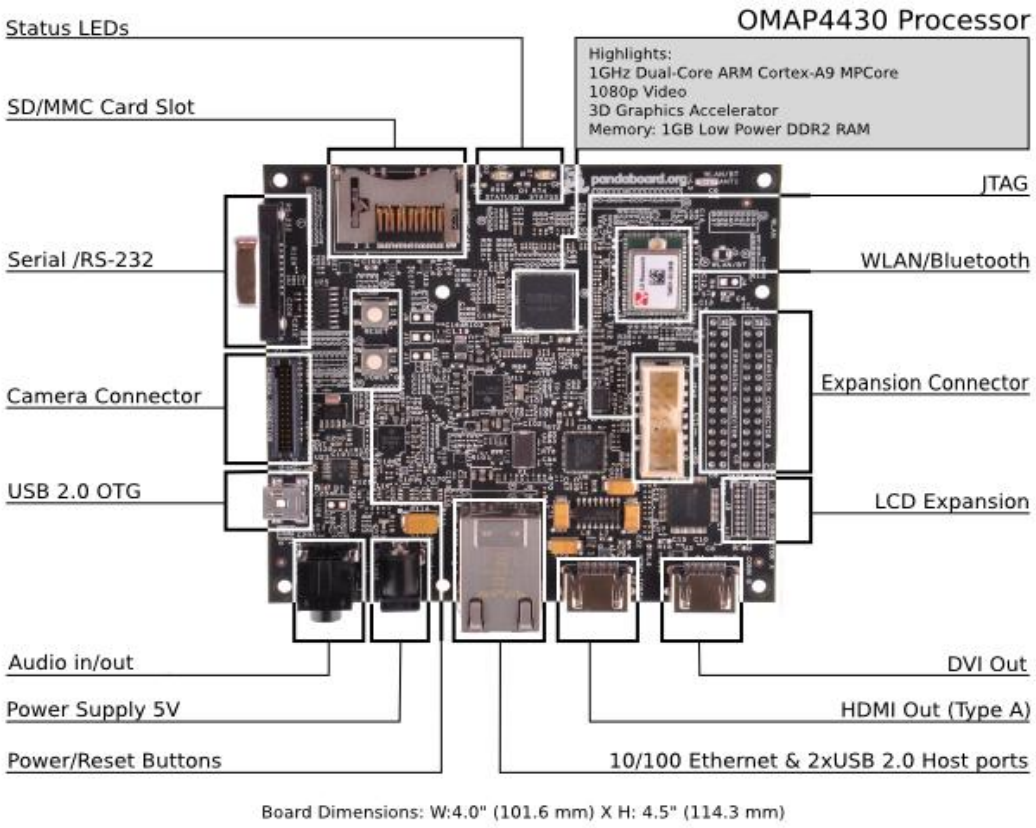
Platform and hands-on lab

- Reproducible, maintainable, common education platform for each key area
- Develop hands-on labs for each key area and its database
  - Lab notes
  - Hardware/software packages
  - TA notes
  - References
  - Student reports
  - Discussion forum

Common platform for Telematics

- Panda board

CPU	OMAP4430 applications processor : ● Dual-core ARM® Cortex™-A9 MPCore™ with Symmetric Multiprocessing (SMP) at 1 GHz each. Allows for 150% performance increase over previous ARM Cortex-A8 cores. ● Full HD (1080p) multi-standard video encode/decode ● Imagination Technologies' POWERVR™ SGX540 graphics core supporting all major API's including OpenGL® ES v2.0, OpenGL ES v1.1, OpenVG v1.1 and EGL v1.3 and delivering 2x sustained performance compared to the previous SGX530 core
Memory	● 1 GB low power DDR2 RAM ● Full size SD/MMC card cage with support for High-Speed & High-Capacity SD cards
Connectivity	Onboard 10/100 Ethernet
Expansion	● 1x USB 2.0 High-Speed On-the-go port ● 2x USB 2.0 High-Speed host ports ● General purpose expansion header (I2C, GPMC, USB, MMC, DSS, ETM) ● Camera expansion header
Dimensions	● Height: 4.5" (114.3 mm) ● Width: 4.0" (101.6 mm) ● Weight: 2.6 oz (74 grams)
Display	● HDMI v1.3 Connector (Type A) to drive HD displays ● DVI-D Connector (can drive a 2nd display, simultaneous display; requires HDMI to DVI-D adapter) ● LCD expansion header
Audio	● 3.5" Audio in/out ● HDMI Audio out
Debug	● JTAG ● UART/RS-232 ● 2 status LEDs (configurable) ● 1 GPIO Button



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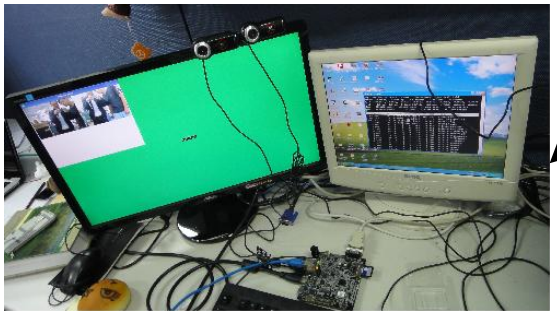
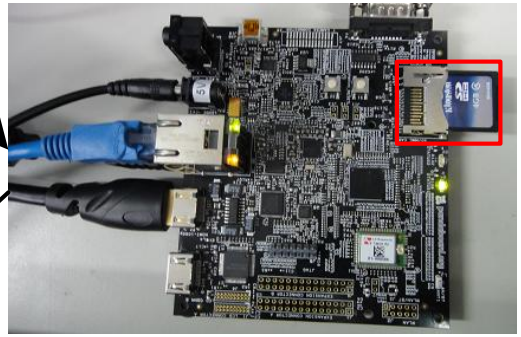
Common platform and lab for Telematics

- Hardware platform

多鏡頭視訊擷取裝置
(USB Camera)



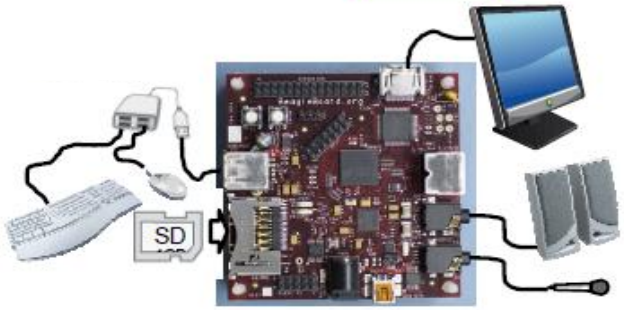
中控顯示裝置
(LCD Monitor)

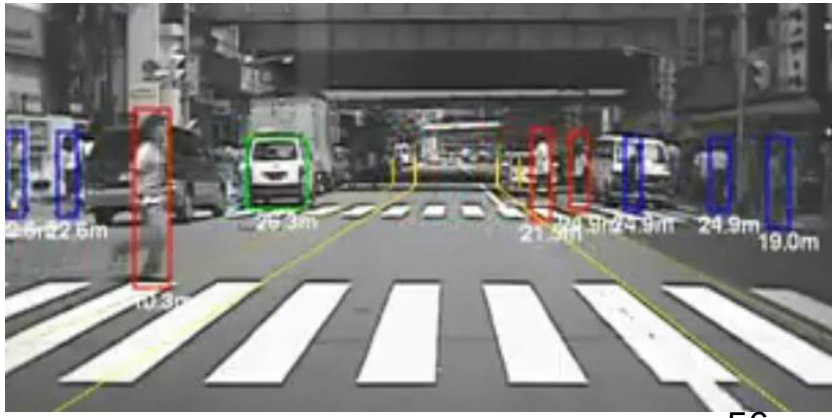


中控運算平台
(OMAP4430 on PandaBoard)

儲存裝置
(SD Card)

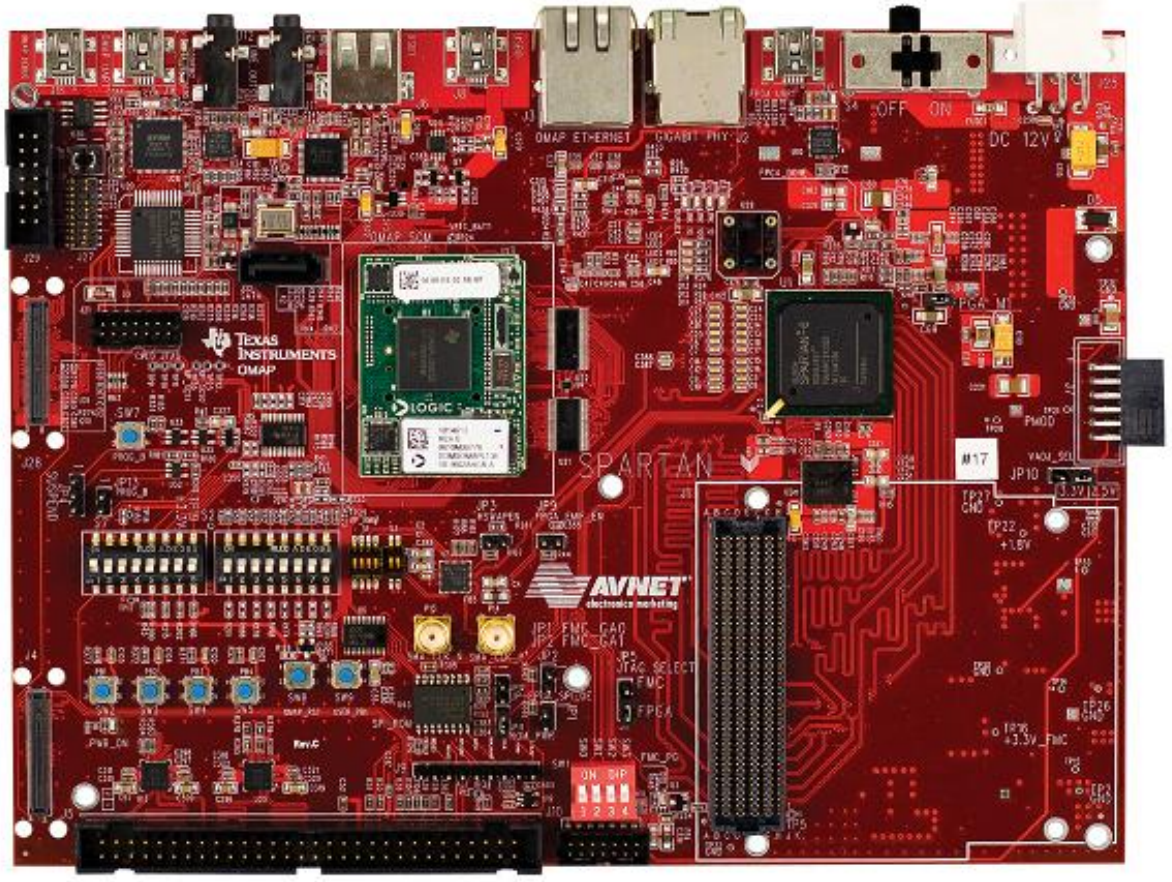
Common platform and lab for Telematics





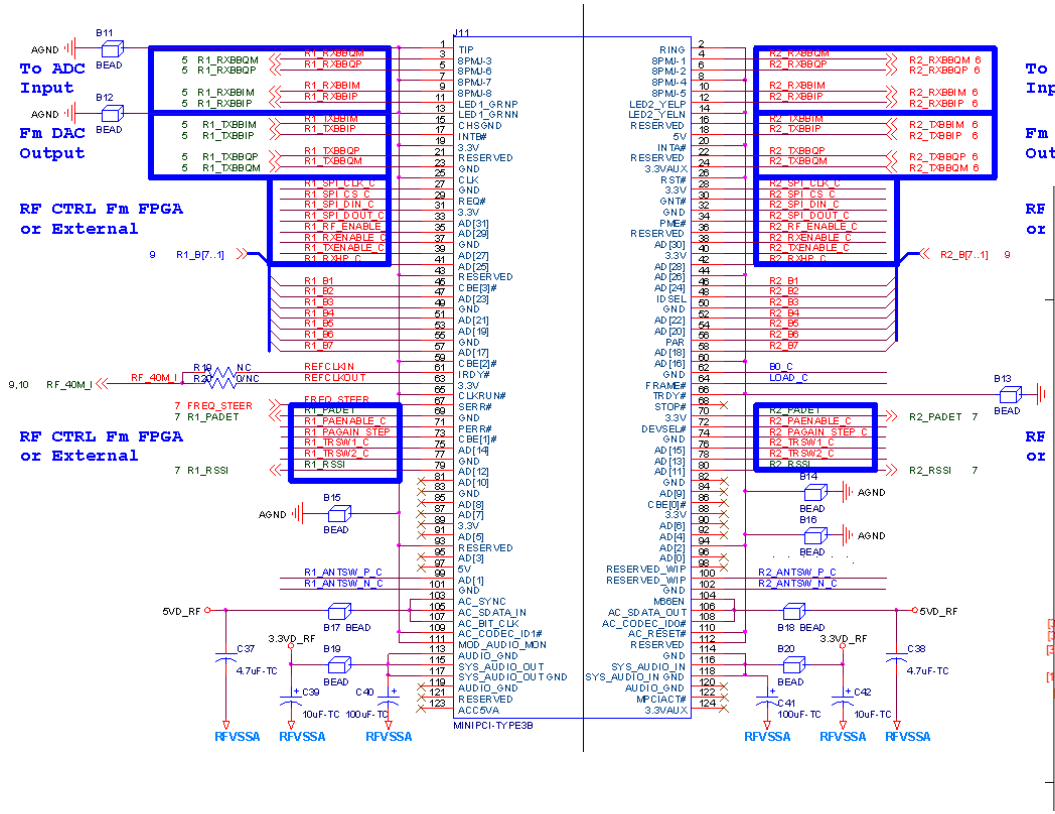
Common platform and lab for cognitive radio

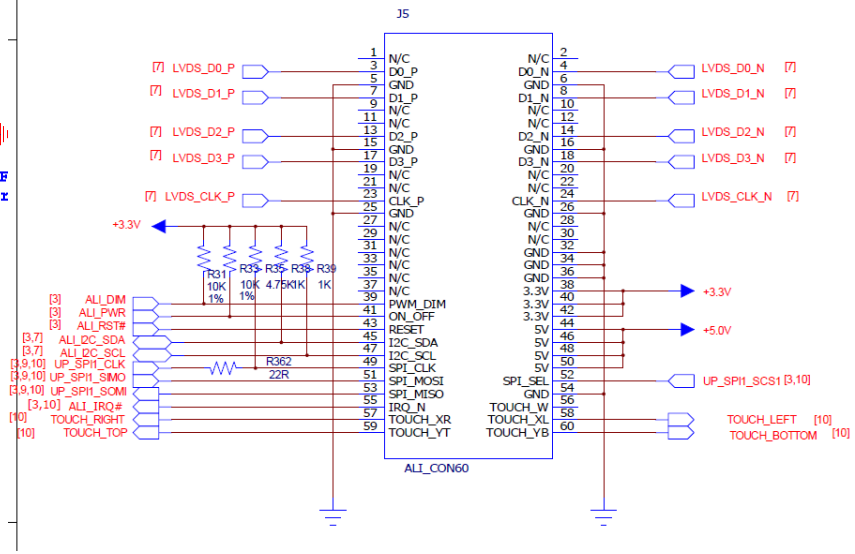
Avnet TI OMAP/Spartan-6 FPGA



Common platform and lab for cognitive radio

RF front end(by local vendor):





Summary

- VLSI Circuit and Systems/SoC Education Program in Taiwan (2000-2010)
- Intelligent Electronics Education Program in Taiwan (2011-2016)
- Embedded System Education Program (2003-2010)
- 4C Electronics (4C) Education Program (2011-2016)

Thanks for your attention