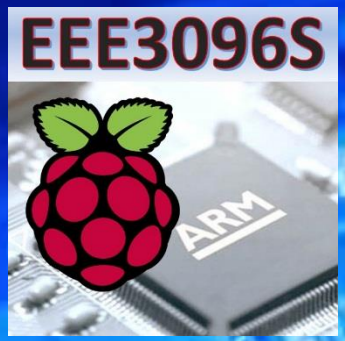
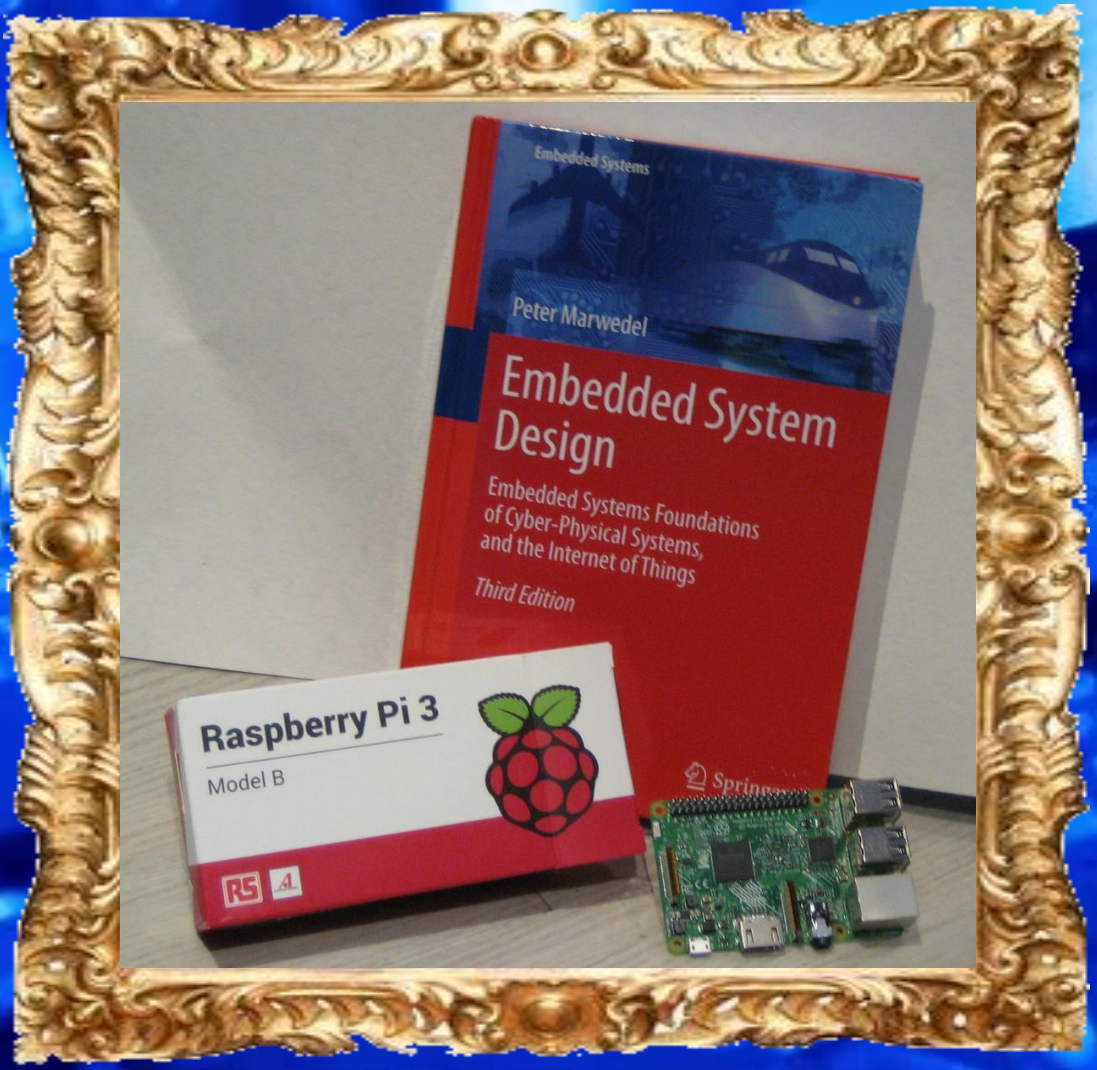


Welcome! to



Lecture L1

Embedded Systems II

Lectured by:
Dr Simon Winberg
Dr Yunus Gaffar

Electrical Engineering
University of Cape Town

Hello! & whoami

Greetings students!

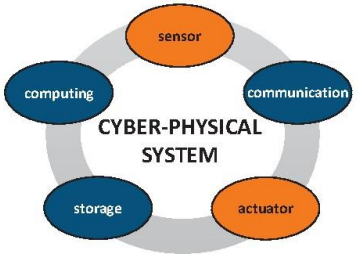
I'm **Simon Winberg**

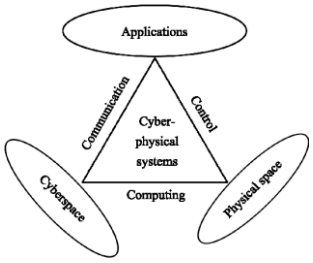
And I'm passionate about

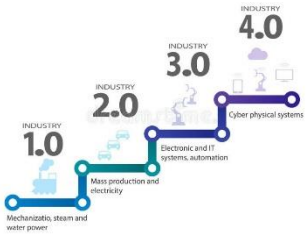
Embedded Systems

~~and~~ more correctly

Cyber-Physical Systems







TEACHING SUPPORT STAFF

- TA:
  - Mr Othniel Konan
- Tutors:
  - Jason Meek
  - Andrew Olivier
  - Zain Salie
  - Dominic Manthoko

Outline of Lecture 1

- Hello! and whoami ✓
- Teaching support staff ✓
- **Changing landscape of work** – things we should know… and why we have this course
- What this course involves
- What is…
  - What is an embedded system? (recap)
  - What is a cyber-physical system?
  - What is ubiquitous computing?
- Why combine these in this course?
- All aboard the Embedded Systems Express
- Class business:

  Vula site & resources; Important issues about the pracs. Some things todo. Getting ahead in EEE3096/5S.

The Changing landscape of work

And why this could be good to know...

Industry 4.0

Watch out because…

‘The game is afoot!’

(as in) – Shakespeare's "King Henry V"

What is…

Industry 4.0?

Industry 4.0

Industry 4.0 =
the name for the current trend of automation and data exchange in manufacturing technologies.

This includes in particular harnessing the power of:

- Cyber-physical systems
- The Internet of things
- Cloud computing
- Cognitive computing

Leading to the concept of
"smart factories“


Smart factories are at the center of the Industry 4.0 (connected industry) revolution.

Many of these plans are a reality, already in place especially at large companies that want to stay ahead of the ‘game’.

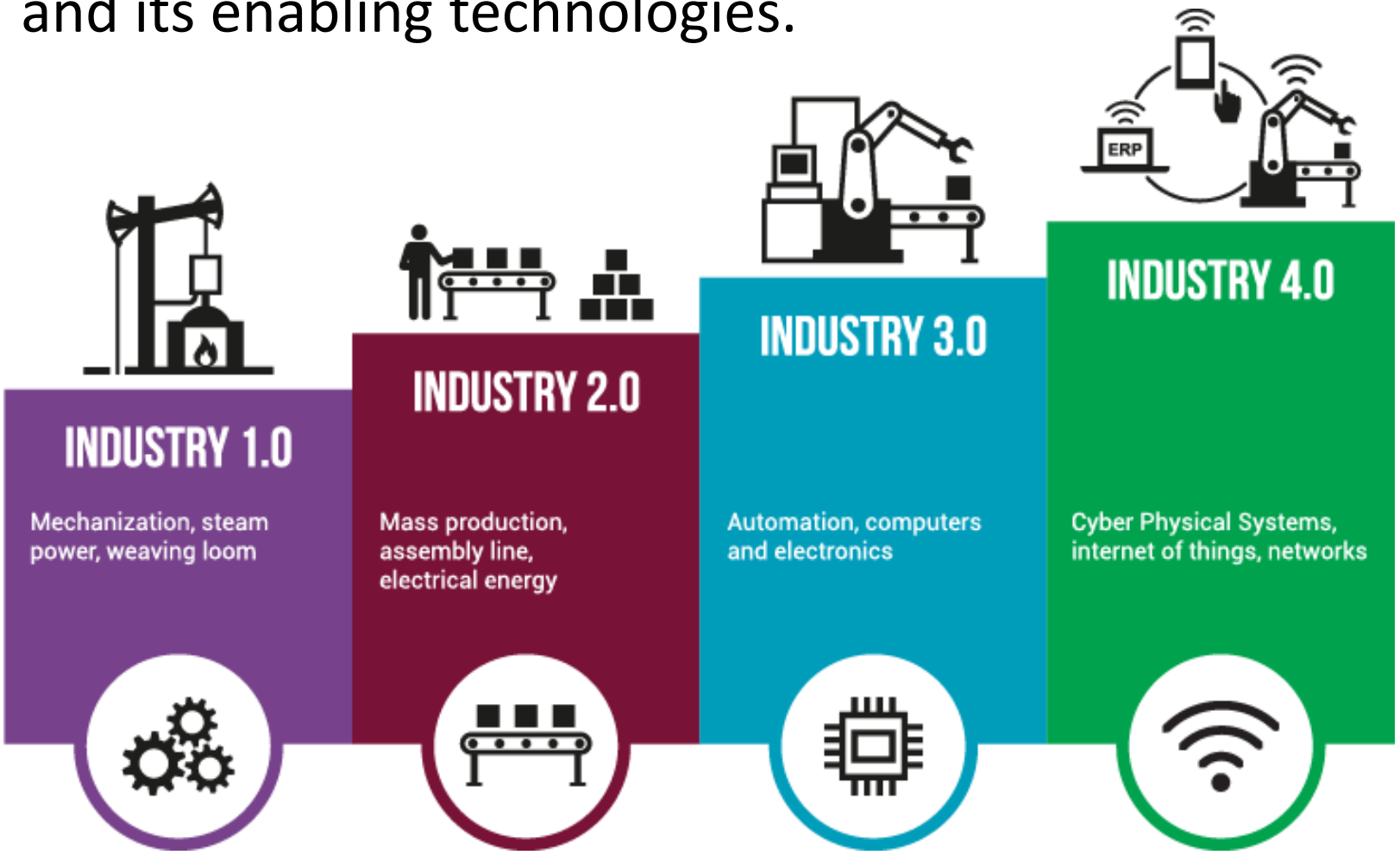
Industry 4.0

… harnessing the power of:

- Cyber-physical systems
- The Internet of things
- Cloud computing
- Cognitive computing

Obviously this can – and is – leading to **massive changes** in the way production works… and more generally how modern businesses will work. These concepts will reach beyond ‘factories’, making more widespread changes in the way we do things.

What economists are now calling, ‘Industry 4.0’ and its enabling technologies.



‘Industry 4.0’ is a term coined at the Hannover Fair in Germany, 2011, to describe how organizations are changing*

Image source: Nitin's Fundas Blog Spot – “Reflections on Leadership, Innovation, Self Development, Spirituality and Transforming India” (http://nseth71.blogspot.com/)

* K. Schwab, “The Fourth Industrial Revolution”, Portfolio Penguin. 2017

Each advance has required

More skilled workers

Education

Generally ever greater portion of the workforce being

‘knowledge workers*’

* Peter Drucker (1959) “The Landmarks of Tomorrow”

IS Industry 4.0

GOOD

OR

BAD

??

Are Industry 4.0 Technologies

You might ask the same of the previous industrial revolutions…

GOOD

or

BAD

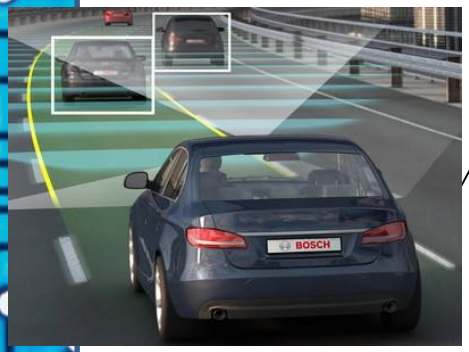
?

e.g. Industry 1.0 was epitomized by machination, machines people used to work faster. But it demanded a huge number of people who knew how to use these machines. It was a big transition from serve poverty and poor health towards people who essentially had more freedom.

Technologies that are 'successful' may impact the world to a greater or lesser extent. But generally once a technology is invented it can't be undone ('immutability of invention'). So you might as well see if it can benefit you ☺

Impact on jobs (slight aside)

- Major impacts are:
  - **Innovation** at the forefront like never before
  - **Speed:** things happening faster than ever
  - **Labour substitute:** repetitive and highly prescribable tasks done by machines…



Think: taxi drivers vs. self-driving cars

Think: cashiers vs. self-checkout / Tesco scan as you shop

Think: human soldier vs. The Atlas and similar Robot Soldiers

How will these trends effect jobs?

Put very briefly…

Jobs most prone to automation*

Probability	Occupation
0.99	Telemarketers
0.99	Tax preparers
0.98	Insurance Appraisers, Auto Damage
0.98	Umpires, Referees, and Other Sports Officials
0.98	Legal Secretaries
0.97	Hosts and Hostesses, Restaurant, Lounge, and Coffee S
0.97	Real Estate Brokers
0.97	Farm Labor Contractors
0.96	Secretaries and Administrative Assistants, Except Legal, Medical & Executive
0.94	Couriers and Messengers

Least prone to automation

Probability	Occupation
0.0031	Mental Health and Substance Abuse Social Workers
0.0040	Choreographers
0.0042	Physicians and Surgeons
0.0043	Psychologists
0.0055	Human Resources Managers
0.0065	Computer Systems Analysts
0.0077	Anthropologists and Archaeologists
0.0100	Engineers / Technologists**
0.0130	Sales Managers
0.0150	Chief Executives

Where do (elec./comp.) engineers and computer scientists end up?...

* K. Schwab, "The Fourth Industrial Revolution", Portfolio Penguin. 2017

**The author more indicates marine engineers and architectures in the original table but reading further in the book you can interpret that engineers, particularly those involved in developing and maintaining complex systems are unlikely to become automata, at least not anytime soon.

Should we be worried?

The short answer is…

For now… probably not! ☺

But hopefully this little journey though industry trends and how embedded systems and CPS are strong related to methods of many modern business has been informative, if not inspiring.

And remember that

> "Education is the most powerful weapon which you can use to change the world."
>
> *… said who? …* – Nelson Mandela

And hopefully you will use what you learn to make the world a better place!

OK, enough consideration about where ES fits in!!...
Now we are ready to begin the journey proper!

ALL aboard The Embedded Express

Onwards to Embedded Systems!

What this course involves

PART I

- Embedded Systems (ES) Theory & Practice
- Embedded Operating Systems
- Modelling and Simulation of ESs
- Computer Architecture
  - focusing on theory and practices for design and analysis of ESs

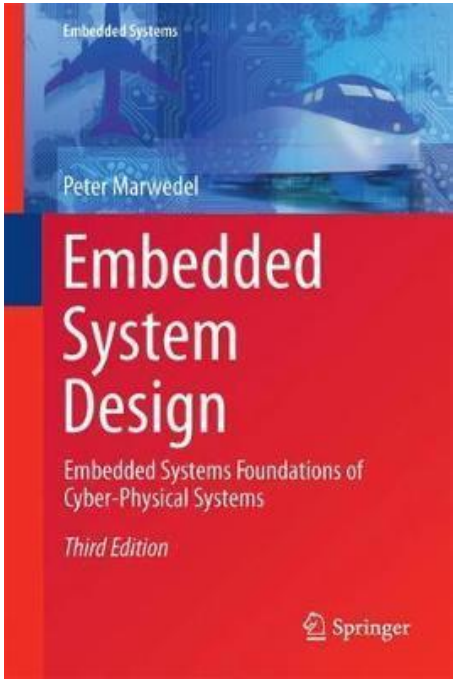
PART II

- ARM Assembly Language
- An introduction to Hardware Description Language (HDL)

Design of this course

- This course is design around
  - Platforms and tools in pracs
  - Theory covered in the textbook…

Textbook

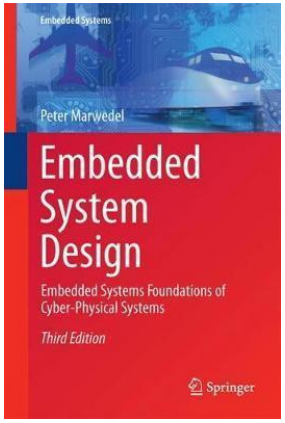


Why this choice? It's probably obvious…
This (his Edition 2) is currently trending as a very popular textbook, used in top-rated universities, particularly in Europe (especially German) as well as a number of Chinese and Japan universities known for their good CPS graduates.

Embedded System Design:
Embedded Systems
Foundations of Cyber-
Physical Systems, and the
Internet of Things
By Peter Marwedel

Design of this course

- This course is design around
  - Platforms and tools in pracs
  - Theory covered in the textbook
- Aspects of textbook's companion resources are reused and adapted, this has been done with permission of the textbook author:



Prof. Peter Marwed *from*
Technische Universitat Dortmund
Germany

Adaptation includes cutting some content and adding more relevant topics and issues for our context.

What is an Embedded System?

Defining an Embedded System

"Dortmund (2011) Definition": [Peter Marwedel]
Embedded systems are information processing systems embedded into a larger product.

"Berkeley (2004) Definition": [Edward A. Lee]
Embedded software is software integrated with physical processes. The technical problem is managing time and concurrency in the computational systems.

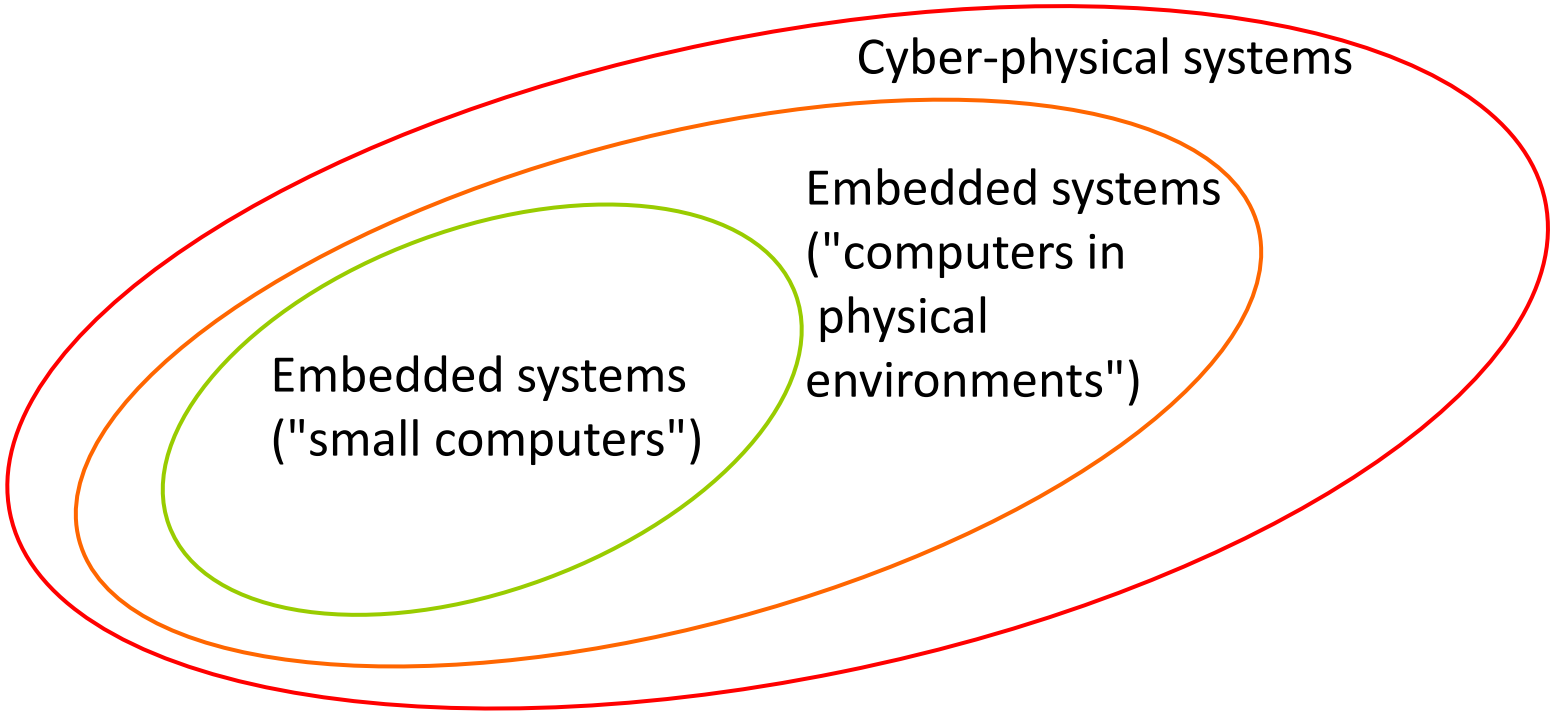
"Brisbane, Australia (2009) Definition": [John Catsoulis]
An ES is a task-specific computer, which is built into a larger system for the purpose of controlling and monitoring the larger system.

Cyber-Physical (cy-phy) Systems (CPS) are integrations of computation with physical processes [Edward Lee, 2006].

Cyber-physical system (CPS) = *Embedded System* (ES) + *physical environment* →

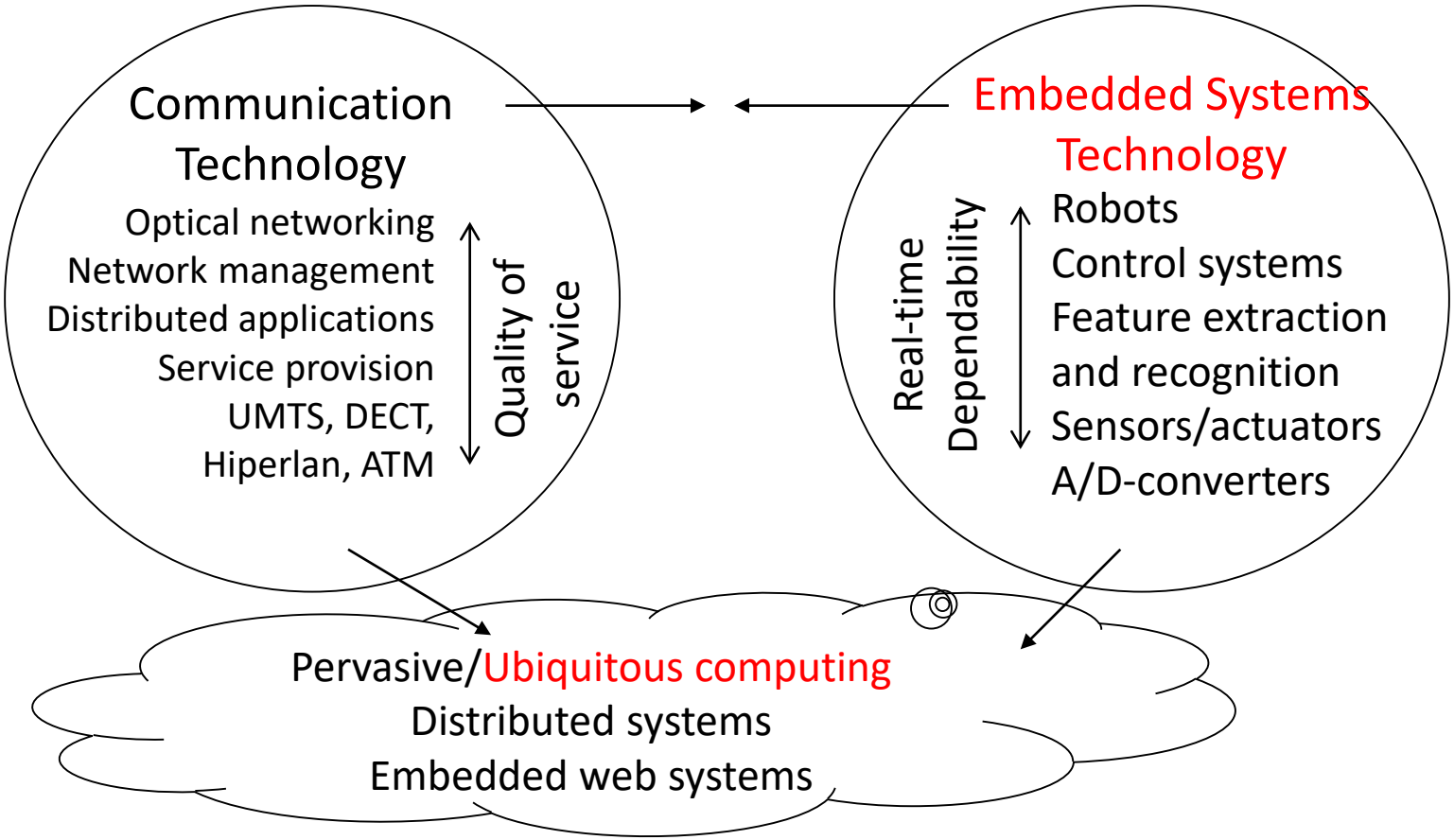
Cyber-physical systems and embedded systems

CPS = ES + physical environment



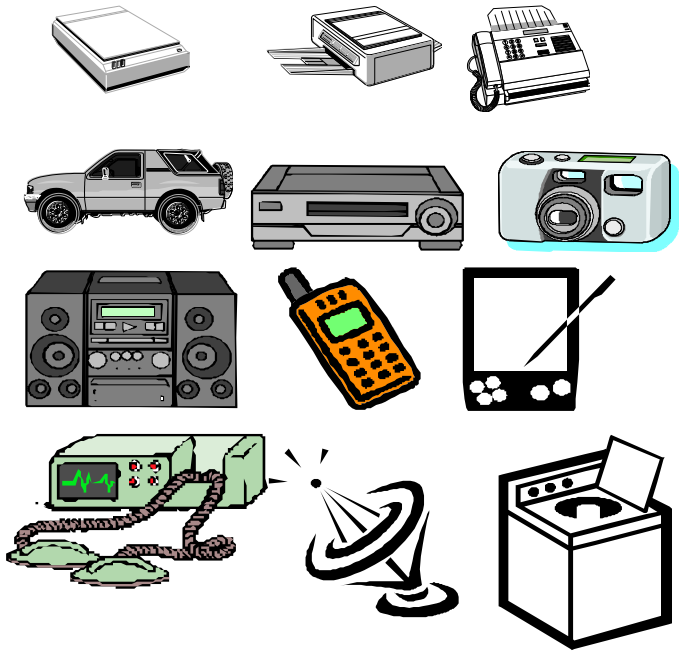
Extending the motivation: Embedded systems and ubiquitous computing

Ubiquitous computing: Information anytime, any-where.
Embedded systems provide the fundamental technology.



Some Embedded Systems

Anti-lock brakes
Automatic teller machines
Automatic toll systems
Automatic transmission
Avionic systems
Battery chargers
Camcorders
Cell phones
Cell-phone base stations
Cordless phones
Cruise control
Digital cameras
Disk drives
Electronic card readers
Electronic instruments
Factory control
Fax machines
Home security systems
Life-support systems
Medical testing systems
Microwave ovens
Modems
MPEG decoders
Network cards
Network switches
Pagers
Photocopiers
Point-of-sale systems
Portable video games
Printers
Satellite phones
Scanners
Speech recognizers
Stereo systems
Televisions
Temperature controllers
Theft tracking systems
VCR's, DVD players
Video game consoles
Washers and dryers



What's your favourite Embedded system??

List in part obtained from: Vahid Givargis, *Embedded Systems Design: A Unified Hardware/Software Introduction*, 2000

Deciding if it's an Embedded System

- The borders between *embedded and non-embedded computer system* are getting blurred…
  - Cellphones and PDAs … embedded for not?
  - Set-top box for steaming internet TV?
- Traditional deciding factors are:
  - Task specific
  - Non-standard architecture
  - Limited resources

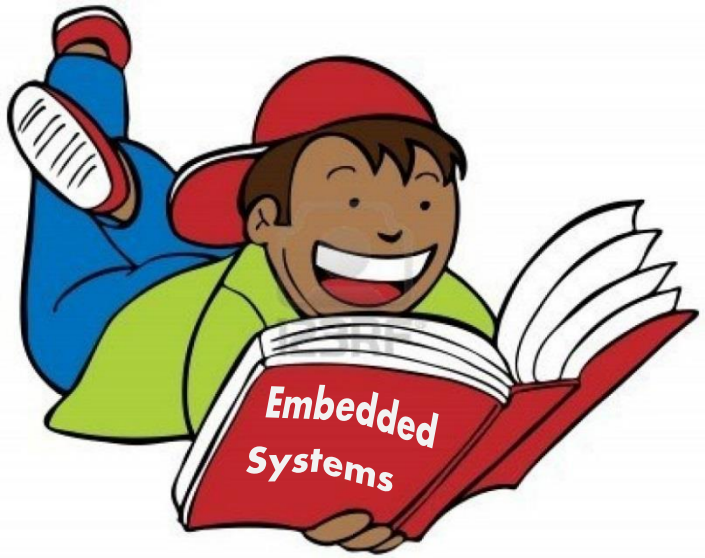
As more computing power moves into embedded systems, borders are getting more fuzzy.

You

TODO

TODO

Read through Chapter 1 of the textbook



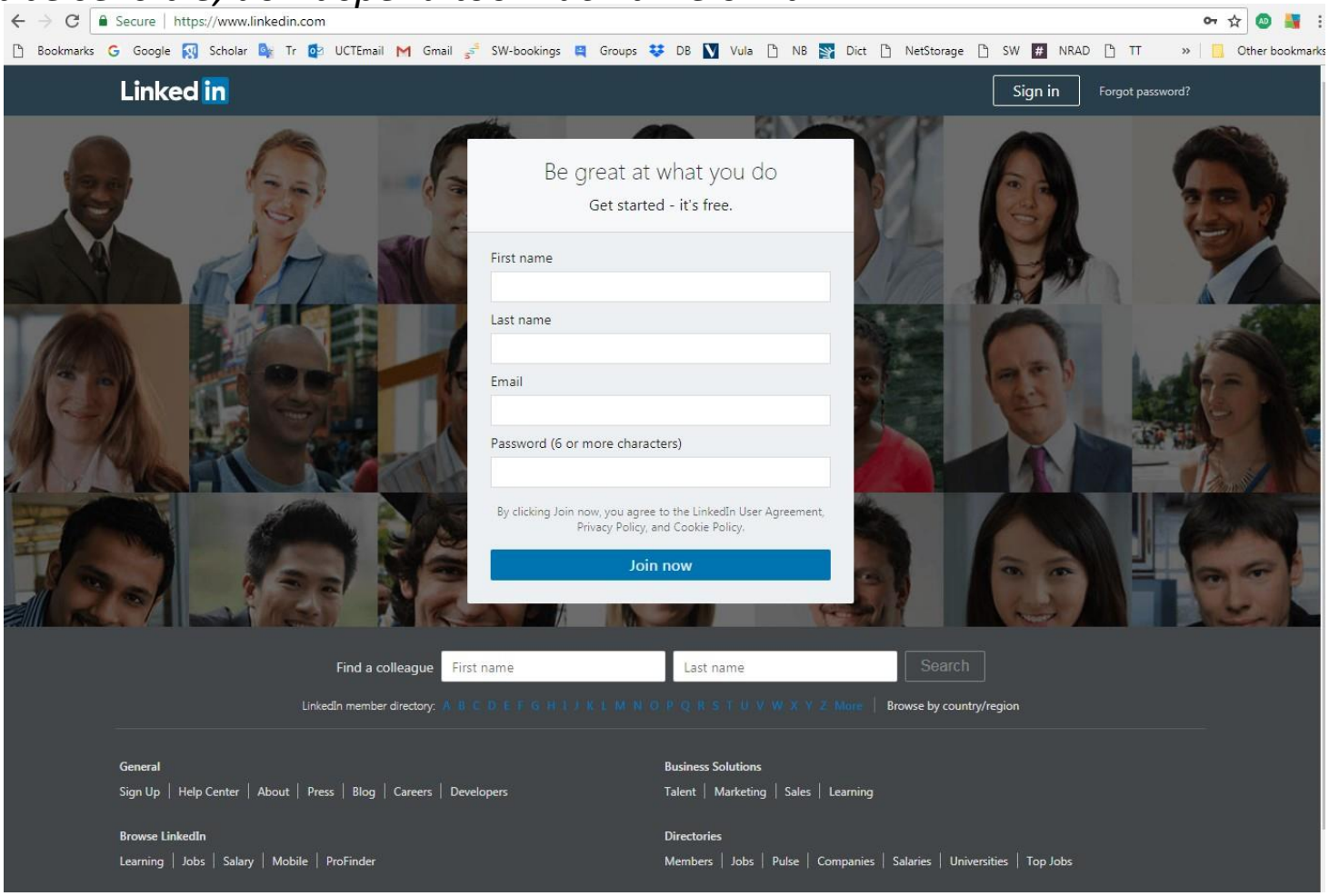
There might be some quick questions on this in the Wednesday lecture.

Recommended

(optional, for those who haven't already done this)

Consider building your own LinkedIn profile! or create one if you don't have.

But be sensible, don't spend too much time on it.



To end off with…

Some class business

When are the labs?

See Vula assignment tab for the instructions.

The labs are planned to start next week on Monday 2pm

Attend one of the lab sessions:

Group	Day & Time	Venue
Group 1A	Monday 2pm-4pm	DCL Lab
Group 1B	Monday 2pm-4pm	Blue Lab
Group 2A	Monday 4pm-6pm	DCL Lab
Group 2B	Monday 4pm-6pm	Blue Lab
Group 3A	Tuesday 2pm-4pm	DCL Lab
Group 3B	Tuesday 2pm-4pm	Blue Lab
Group 4A	Tuesday 4pm-6pm	DCL Lab
Group 4B	Tuesday 4pm-6pm	Blue Lab

Some labs will have more than one session assigned to it, you don't have to attend a lab session but you do need to complete the practical assignment. You can work on your own PC if you want to.

Getting Ahead in EEE3096S

What **not** to do

- **Don’t do Plagiarism, crime or other offenses**
  - The University takes plagiarism very seriously
- **Don’t Let other students do your work**
  - Hand in only your own work for individual assignments
- **Don’t do other students’ work**
  - Group work must be divided up fairly
  - Keep track of each member's contribution

What you **can do**

- **Assist / suggest advice to other students**
  - Give procedural assistance in the labs
  - Refer other students to useful information and references
- **Good referencing practice**
  - Where you use somebody else's work, reference it properly. e.g. use IEEE referencing or Harvard referencing method

In The Lab

- **Think**
  - Develop a plan of action, before you start hacking!
- **Try**
  - Before saying that you don't know, try it!
- **Don't fry**
  - Don't be careless and fry the lab equipment (or yourself!)

No frying or braaing in the lab!

The Next Episode…

Lecture P01

The Raspberry Pi, its architecture and some tools. Headless access. Use of ssh and terminal, useful commands.

Lecture numbering:

- Lnn : Theory lectures
- Pnn : Practice related lectures