Introduction to UCL, Department of E&EE and to Telecommunication Networks

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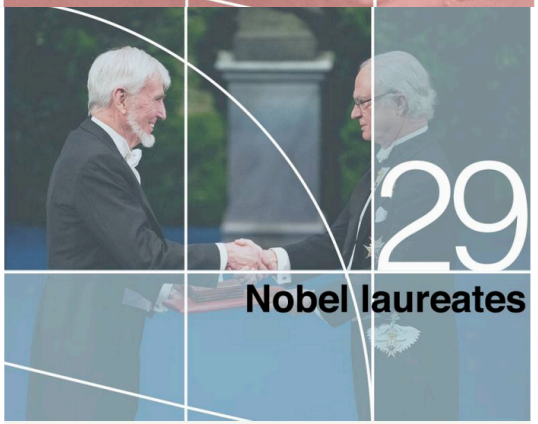
Our university

- UCL is a radical university that seeks to pioneer the new ideas and technologies that will shape the future.
- UCL is consistently judged to be one of the top three multi-faculty universities in the UK for the scale and quality of its research.
- UCL's teaching and research place it as one of the top world universities.
- With almost 45000students (over 6000 research postgraduate) UCL is a centre of excellence for education and world-class research.



About UCL

- Founded in 1826 as the University of London
- Third oldest University in England
- Founded for students of ‘any religion or no religion’ and any social background
- First university to welcome women in England
- First university to teach engineering in England
- First EE department in England
- First Internet node outside the USA
- 10th in the world (QS World University Rankings 2021)
- 29 Nobel laureates
- Net income (2018)~ £1500 million
- Very high research income (£600m)

Student Population

- 43,800 students of whom~23,850 are graduate students*
- 6000 research students
- 60% women- 40% men
  - (64%-36% for graduate students)
  - In Engineering 33% to 67%)
- 15,700 international students from 142 different countries

http://www.ucl.ac.uk/

https://www.ucl.ac.uk/srs/statistics

*(all 2019 figures)

Electronic and Electrical Engineering at UCL

- 45 Academic Staff, 25 Research Fellows, 130 Research Students
- 5 Research Groups
  - Electronic Materials and Devices
  - Photonics
  - Microwaves Sensors and Circuits
  - Optical Networks
  - Communications and Information systems
- 8 specialist Masters programmes
- Special strength in advanced devices, communications and systems
- >250 Publications and 5 filed Patents per year

MSc Programmes at E&EE

- Eight MSc programmes with annual intake of ~ 70-90 (100 in 2020)
- ~75% Overseas and 25% Home/EU
- Intake/application ration: ~ 1/6 (600-800 applications annually)
- Most students taken have 2.i or better
- FT programmes are one year (12 months)
- On average over 90% graduate within the one year
- 20-30 projects each year done in industry
- Mix of one week teaching and teaching spread across the term
- MSc courses available as CPD and industry/flexible MSc

https://www.ucl.ac.uk/iccs/news/2018/aug/ucl-ranked-2nd-uk-telecommunication-engineering

Eight MSc programmes

May be divided in three areas of studies

1- Communications Programmes: all taught in one week modules; many modules are shared across programmes

- MSc in Telecommunications (12 students)
- MSc in Wireless and Optical Communications -WOC (16 students)
- MSc in Internet Engineering (8 students)
- MSc in Communications research MSc in Telecommunications with Business –(16 students)

TwB Our unique “MBA-like programme (50% technical and 50% business modules)

2- MSc in Machine Learning (36 students)

3- MSc in Nanotechnology (13 students)

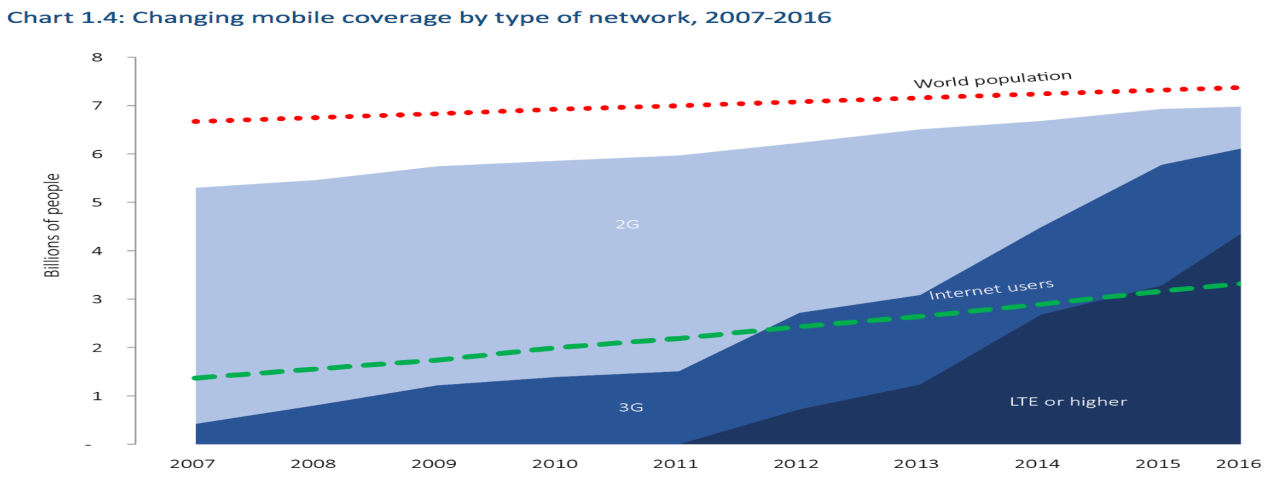
IGDP in Telecommunications; flexible programme (2-5 years) for students from industry (15 students currently)

UCL and Communications

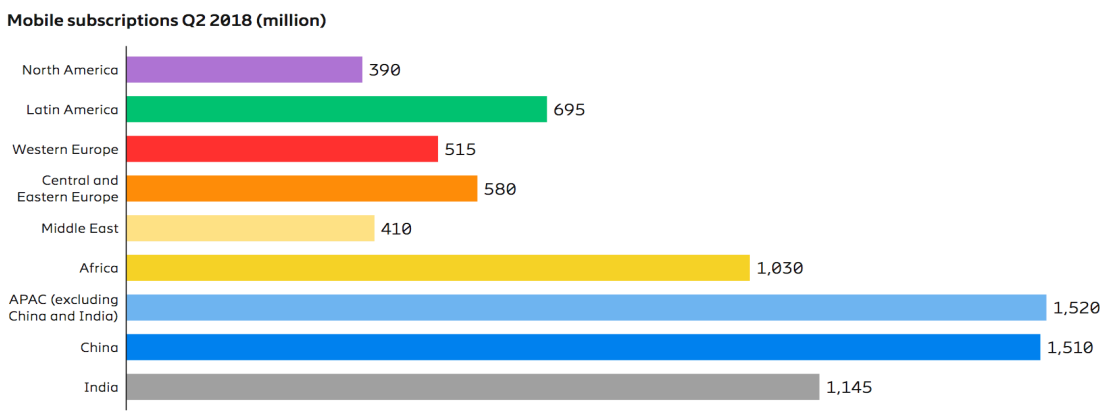
Communications and Telecommunications related research undertaken at UCL since the early 1900s. Fleming, whilst a Professor at UCL, invented the Thermionic Valve.

- Alexander Graham Bell
  - Student at UCL; inventor of the telephone
- Professor Sir John Ambrose Fleming FRS
  - First Professor of EE at UCL; inventor of the thermionic valve
- Marconi
  - Fleming designed the equipment for Marconi's transatlantic radio experiments
- Yagi
  - Studied under Fleming at UCL; inventor of the Yagi antenna
- Barlow
- Professor of EE; invented circular waveguide for long distance broadband transmission
- C.Kao
  - PhD student at UCL, Nobel Prize winner for optical fibre communications
- J. Midwinter
  - Professor of EE; pioneering work on optical fibre transmission

Mobile and the Internet are the fastest developing fields of knowledge and engineering



https://www.itu.int/en/ITU-D/Statistics/Documents/publications/misr2017/MISR2017_Volume1.pdf



–https://www.ericsson.com/assets/local/mobility-report/documents/2018/emr-q2-update-2018.pdf

INTERNET and Mobile

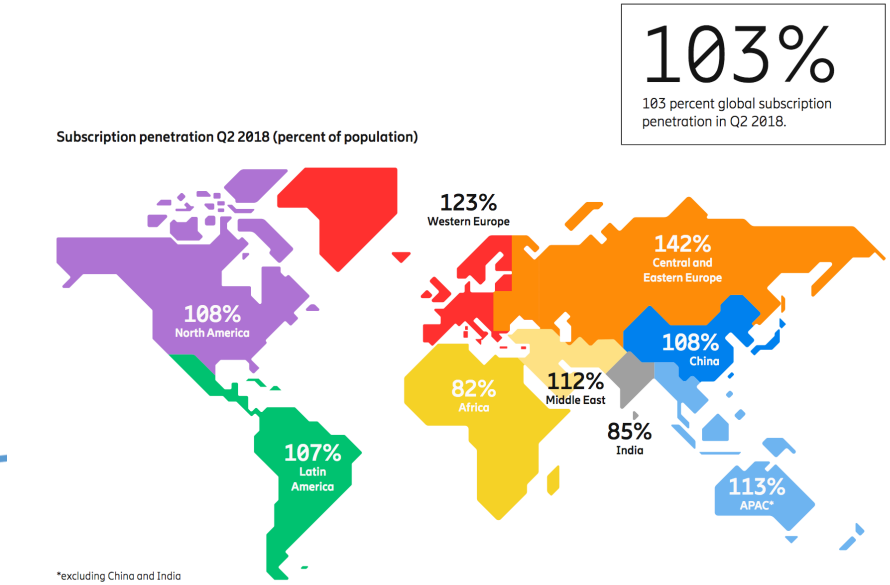
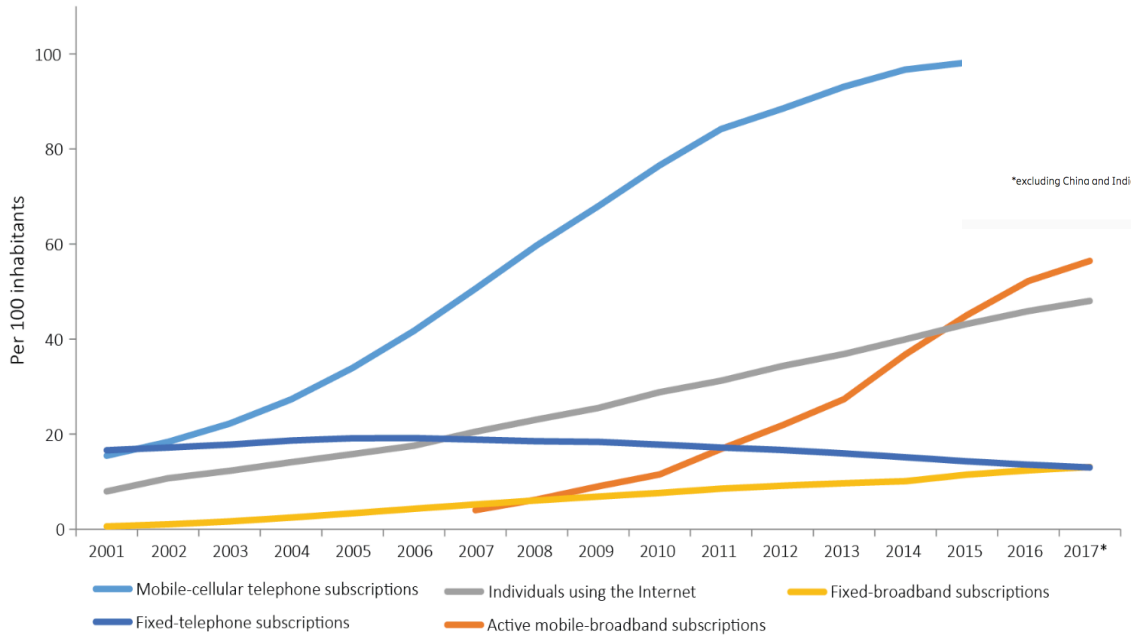


Chart 1.1: Global ICT developments, 2001-2017*



Notes: * ITU estimate.
Source: ITU.

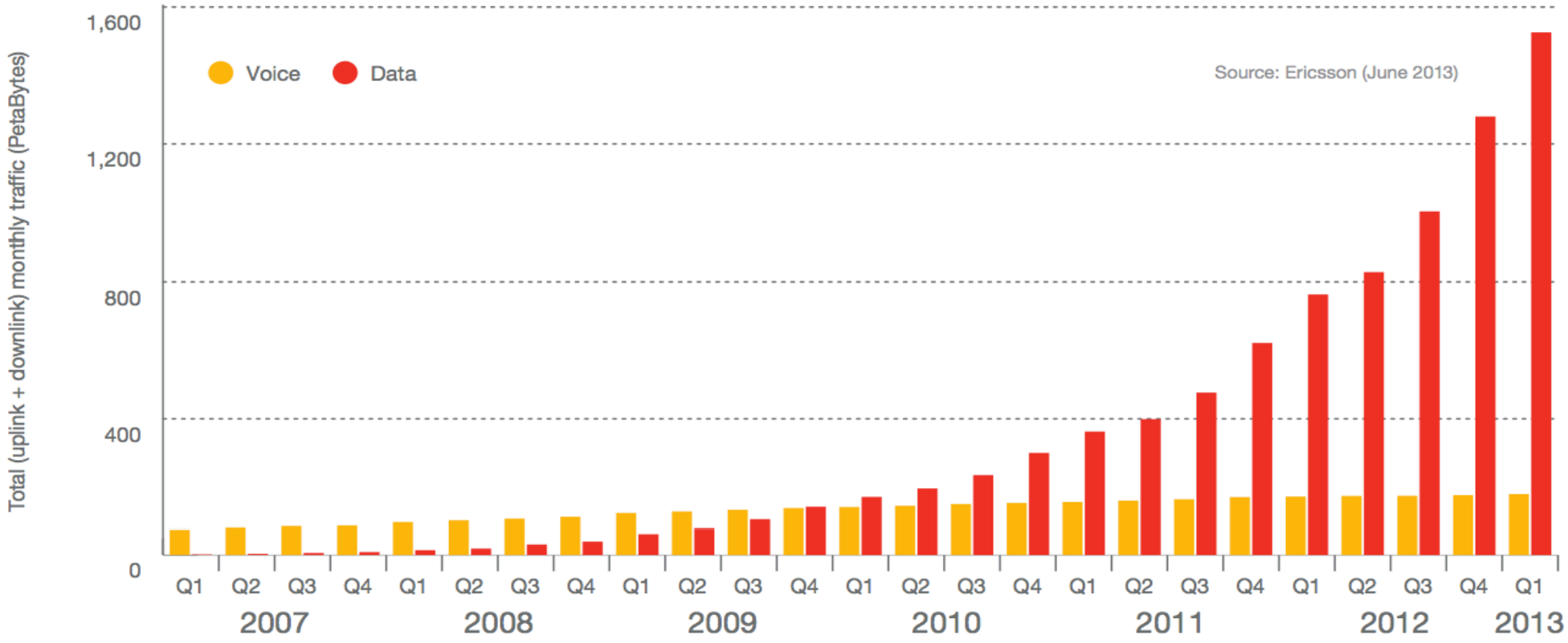
Converged Traffic; Mobile voice and data

Exa Byte =

Voice Data Year-on-year growth

18 180

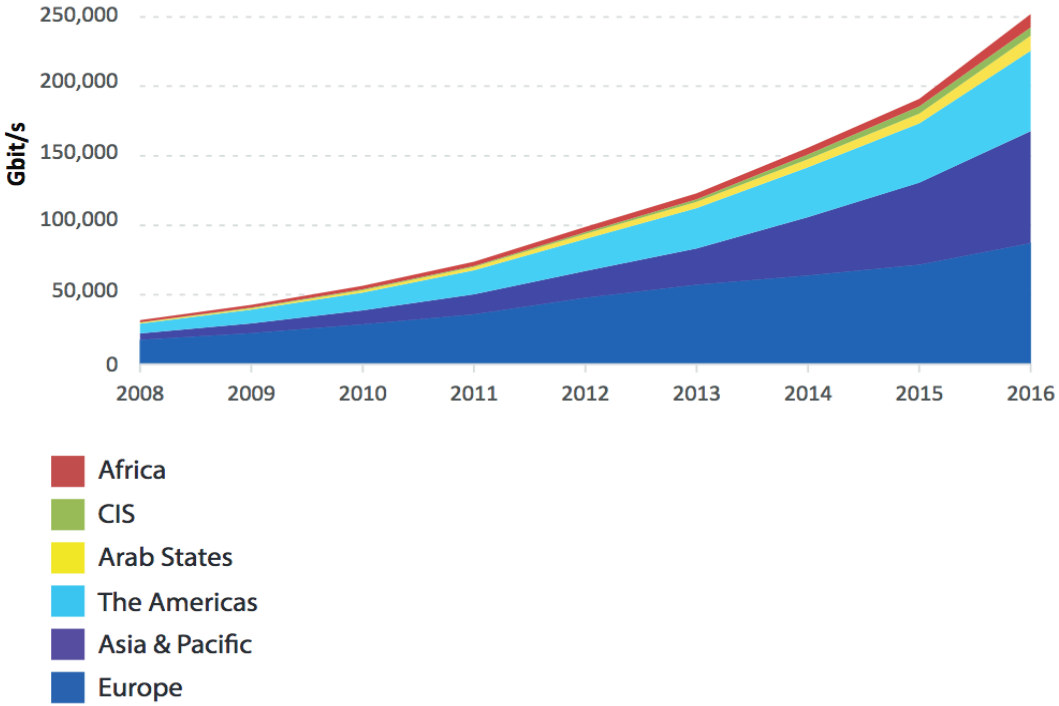
Figure 9: Global total data traffic in mobile networks, 2007-2013



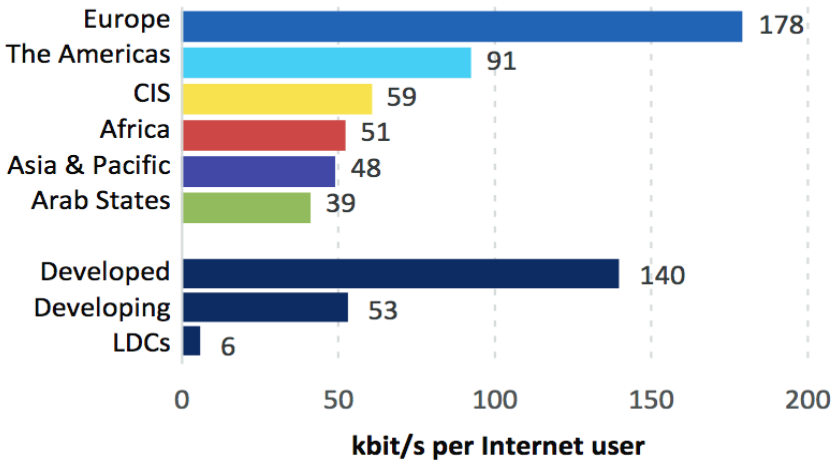
[1] Traffic does not include DVB-H, Wi-Fi, or Mobile WiMax. Voice does not include VoIP. M2M traffic is not included.

Internet spread shows vast inequalities in distribution

International Internet bandwidth in Gbit/s, per region, 2008-2016



International Internet bandwidth per Internet user in kbit/s, 2016



Source: ITU.
Note: CIS refers to the Commonwealth of Independent States.

International Internet bandwidth grew worldwide by 32% between 2015 and 2016. Africa experienced an increase of 72% during this period, the highest of all regions.

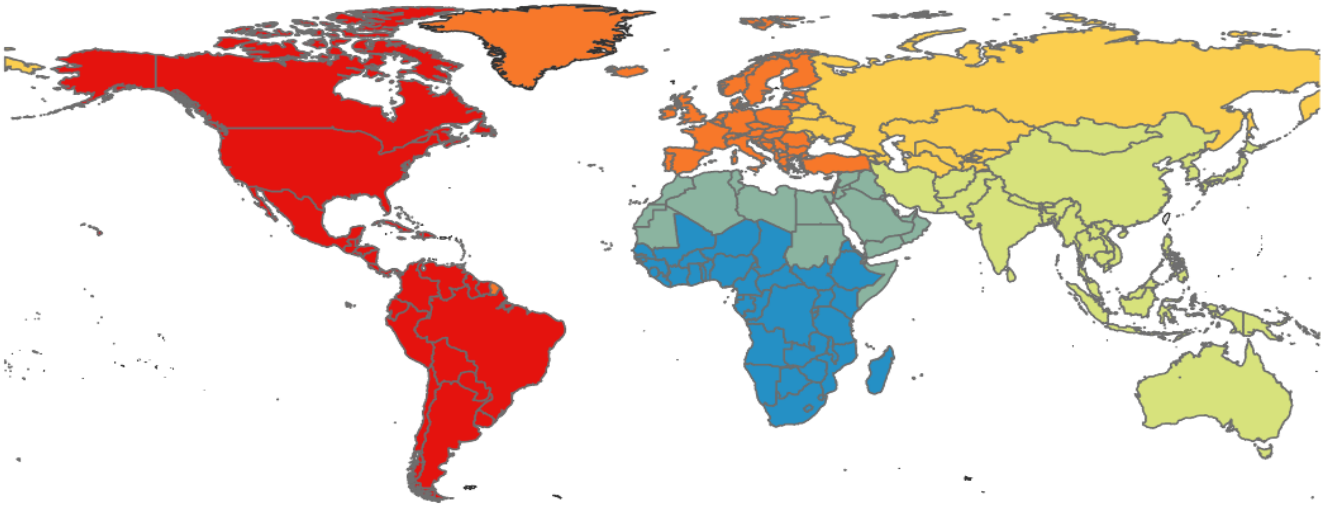
CONTINUOUS HIGH GROWTH OF MOBILE BROADBAND

More than 2 billion subscriptions worldwide by end 2013*

Americas
460 million subscriptions
48% penetration
28% CAGR (2010-2013)

Europe
422 million subscriptions
68% penetration
33% CAGR (2010-2013)

CIS
129 million subscriptions
46% penetration
27% CAGR (2010-2013)



Arab States
71 million subscriptions
19% penetration
55% CAGR (2010-2013)

Africa
93 million subscriptions
11% penetration
82% CAGR (2010-2013)

Asia-Pacific
895 million subscriptions
22% penetration
45% CAGR (2010-2013)

Source: ITU World Telecommunication /ICT Indicators database
Note: * Estimate

What made it possible?

- **Electronics; VLSI, Low noise/low power/high frequency devices, filter technologies, DSP…**
- **Communication systems; for efficient modulation, coding, compression, security, error control**
- **Power sources; for small-long life batteries**
- **Software; for Signal processing and for system design and network management**
- **Radio techniques; for channel prediction and assessment techniques**
- **Telephony; digital telephony, Intelligent Network (IN) and signalling standards**
- **Internet protocols; Allowed the interconnection of millions of heterogeneous networks at a very low cost**

Areas of research work

- **Wireless communications**
  - New methods of saving spectrum –Spectrally efficient systems
  - New methods of saving energy –Green Radio
  - New methods of improving quality- Quality of Service (with medical applications)
  - IoT and VLC
- **Future Internet**
  - Better resilience and availability of Internet and better security of data
  - Autonomic management
  - Content centric networks
  - Networking for cloud computing
- **Optical systems for data distribution**
  - Fibre to the home and passive optical networks
  - Use of optical transmission in high energy physics (CERN work)
- **Theoretical/fundamental**
  - Information theory to find limits of wireless communications
  - Algorithmic development for communication systems (AI and ML)
  - Traffic analysis and Internet modelling based on measurements
- **Circuit design for communication systems**
  - Microwave circuits for 200+ GHz
  - Flexible digital architectures for communication and business (FPGAs)
  - Circuits for carrying data in satellites and in high energy physics experiments

Information and Communications Engineering (ICE) Group

11 FTE academic staff, 2 senior research staff, 17 research associates
~50 PhD students, ~£8.0 million current grants

Academics:

- Professor Izzat Darwazeh (high speed communication circuits, wireless systems)
- Professor George Pavlou (network management, IP networks)
- Professor John Mitchell (optical access and radio over fibre systems, sensor networks)
- Professor Miguel Rio (IP networks, peer-to-peer and next-generation networks)
- Professor Kit Wong (MIMO systems and cognitive radio)
- Professor Yiannis Andreopoulos (multimedia over IP networks, digital signal processing)
- Dr Miguel Rodrigues (Information theory, Machine learning)
- Dr Christos Masouros (Wireless communications, MIMO systems)
- Dr Ioannis Psaras (Data networks and Internet engineering)
- Dr Laura Toni (Multimedia systems and IoT)
- Dr Ryan Grammenos (IoT systems and wireless communications)

Senior Researchers:

- Professor Alex Galis (service and network management)
- Dr David Griffin (IP networks and traffic engineering)
- Dr Stuart Clayman (Data networks and Internet demonstrators)

Business and Technical experts

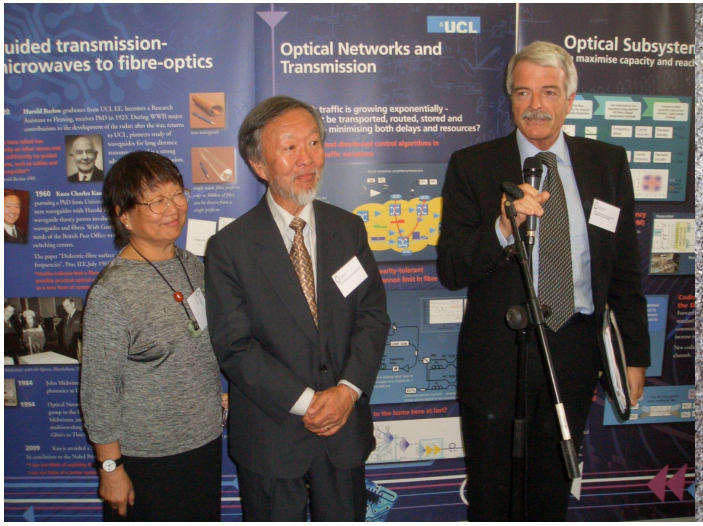
- Dr Clive Poole (telecommunications and mobile business, Microwave circuits)
- Professor Andy Valdar (telecommunications business and strategies)

Information and Communications Engineering (ICE) Group

- Cross-disciplinary group, eg. Health care, art preservation, technical/business aspects of communications
- Very wide industrial, government and academic collaboration worldwide. recent collaborations includes:
  - Research labs and international: CERN, International Telecommunications Union-ITU, QinetiQ, Bell Labs, BAE
  - Operators: BT, France Telecom/Orange, Telecom Italia, Telefonica, BSkyB, Virgin media
  - Electronics companies: ST Microelectronics, Toshiba, ARM, Fixnetix, Thales, Imagination Technologies
  - Communications equipment and industry: Ericsson, CISCO, IBM, Nokia, Hewlett Packard, Aeroflex, Dell, Nokia Siemens Networks-NSN, Alcatel, Selex, Astrium, Inmarsat
  - Others: Price Waterhouse Coopers-PWC, Tate Galleries, BBC, BAFTA, several legal firms

INSTITUTE OF COMMUNICATIONS & CONNECTED SYSTEMS

A unique institute built on a rich history



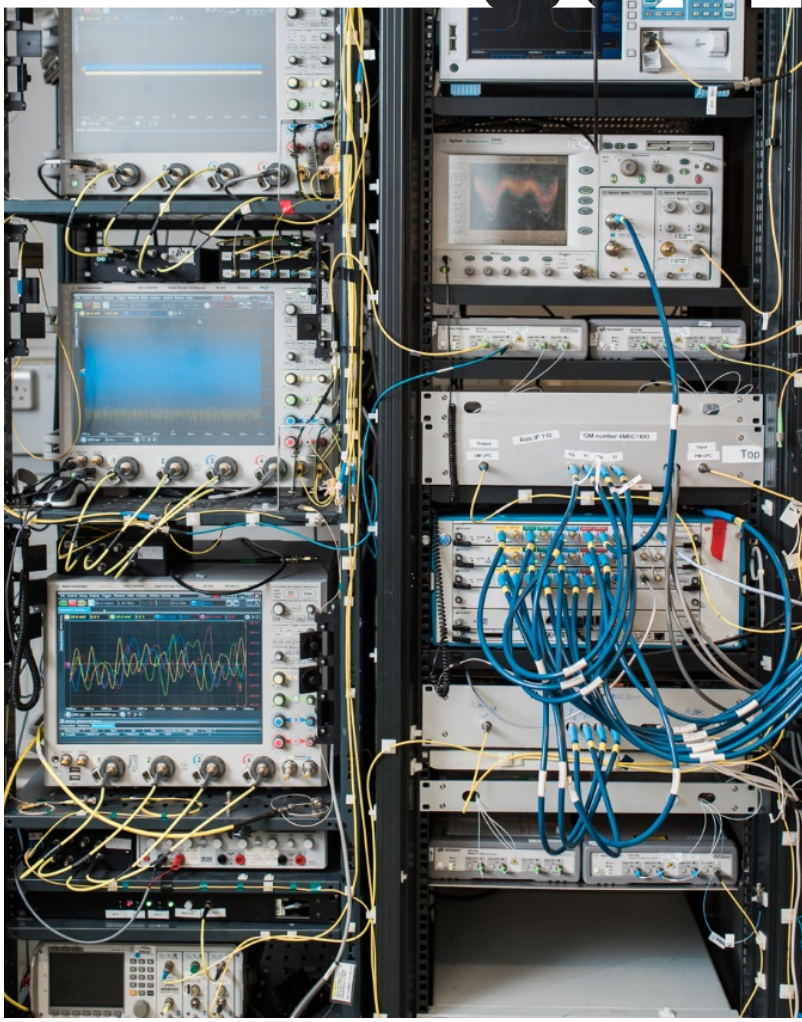
–In UCL E&EE comms and networks

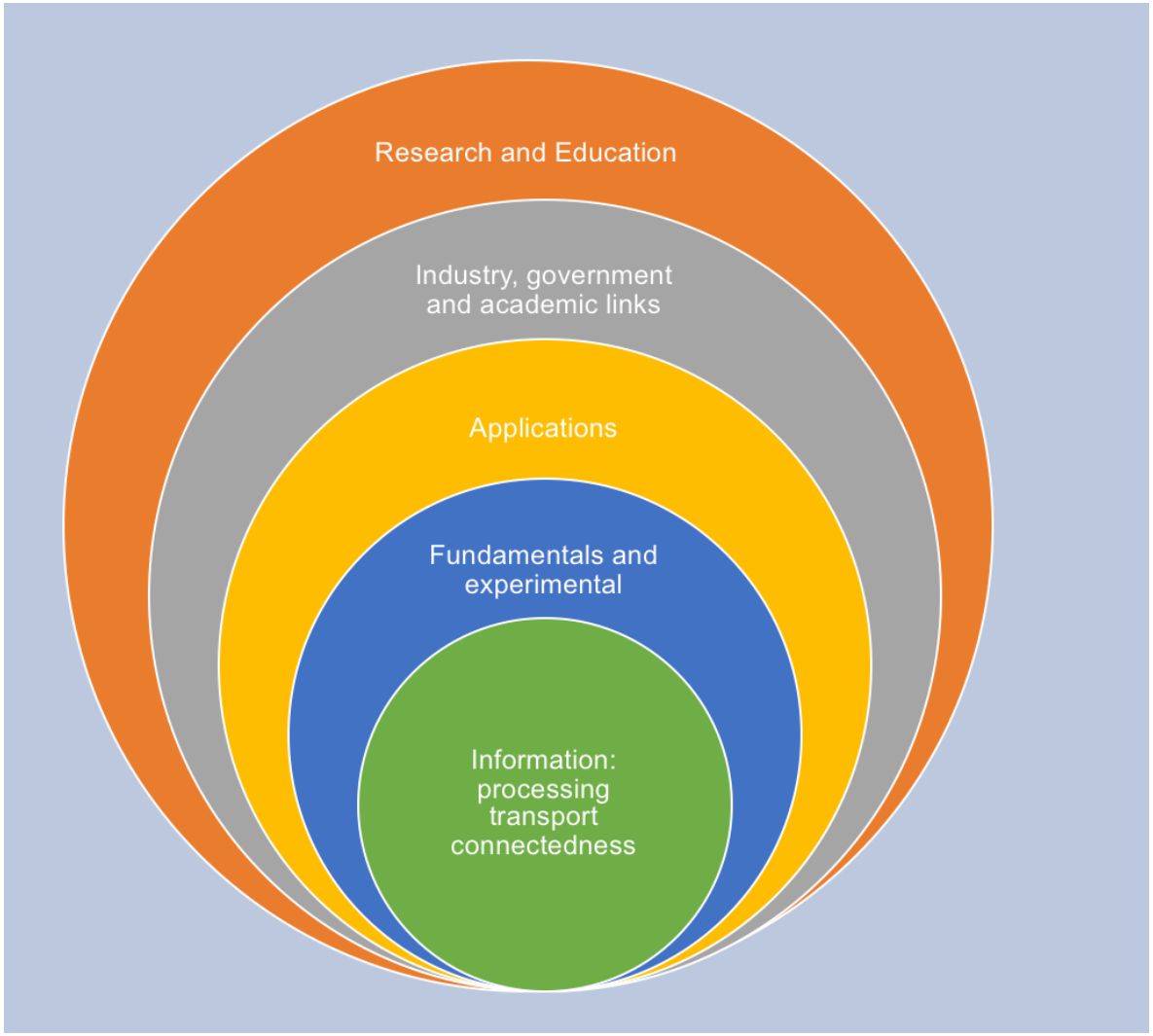
- 100 Researchers in almost all areas of Comms and networks
- Across and beyond all layers
- Extensive industry and public sector links
- World class experimental facilities
- Critical mass to innovate across disciplines

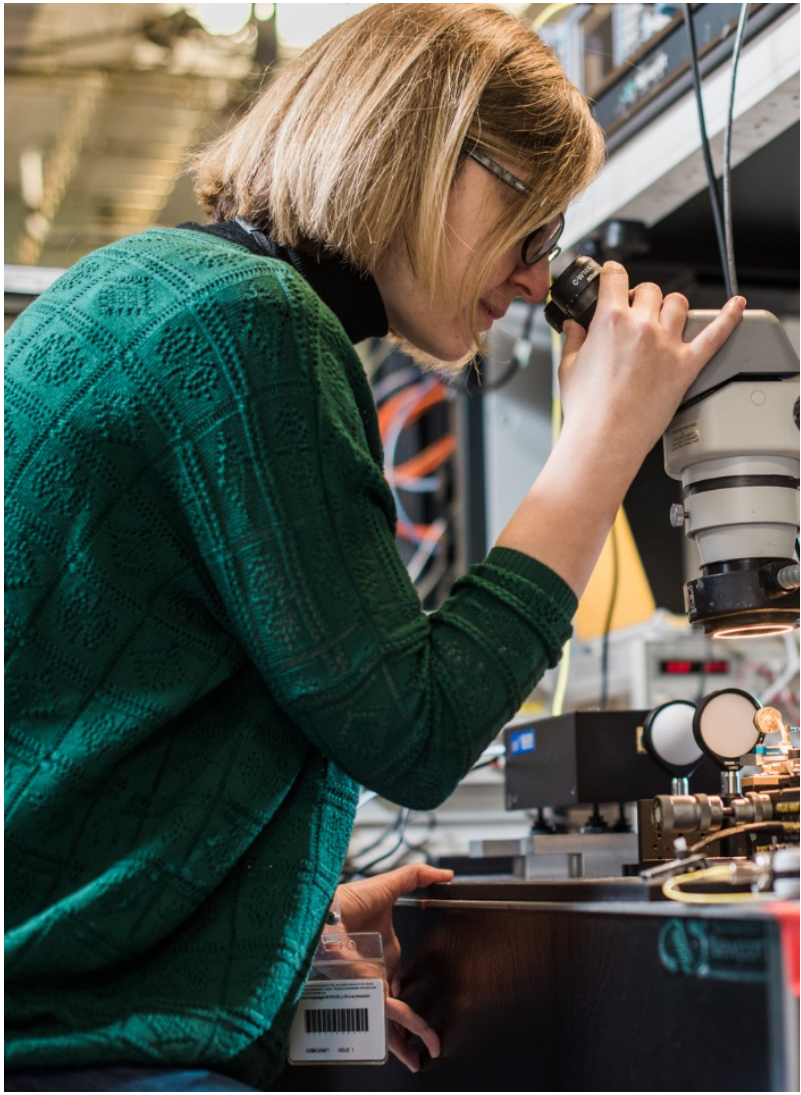
–Wider UCL

- From Robotics to law; economics to privacy and ethics; health care to Quantum computing and from finance to security

–Looking beyond UCL, to the world (with a focus on London)




Research and Education
Industry, government and academic links
Applications
Fundamentals and experimental
Information: processing transport connectedness



Intelligent high capacity networks

Building Communications Technologies for a data-intensive society

Ubiquitous Connectivity

Providing connectivity to everyone and everything, everywhere, every time

Infrastructures for smart services and applications

Connecting and coordinating devices to create an efficient and intelligent ecosystem of services

Sensing, Information and data processing

Acquiring, processing and exploiting information and data for optimum utilisation

GreenComms
DataCentre
Privacy
Wireless
CloudComputing
SensorNets
Imageprocessing
Information
SignalProcessing
Capacity
Tbits
IoT
Fibre
MIMO
D2D
VLC
Healthcare
NVF
Microwave
ICN
SDN
CloudNetworks
mmWave
NetworkMeasurement
Radio
Sensing
Optical
Radar
BigData
PowerEfficiency
Caching
RF
Medical
RoF
IntegratedCircuits
EnergyHarvesting
Security
MassiveMachineComms

NODE 01
NODE 04
NODE 05
NODE 03
BLOCK 01
NODE 01
NODE 02

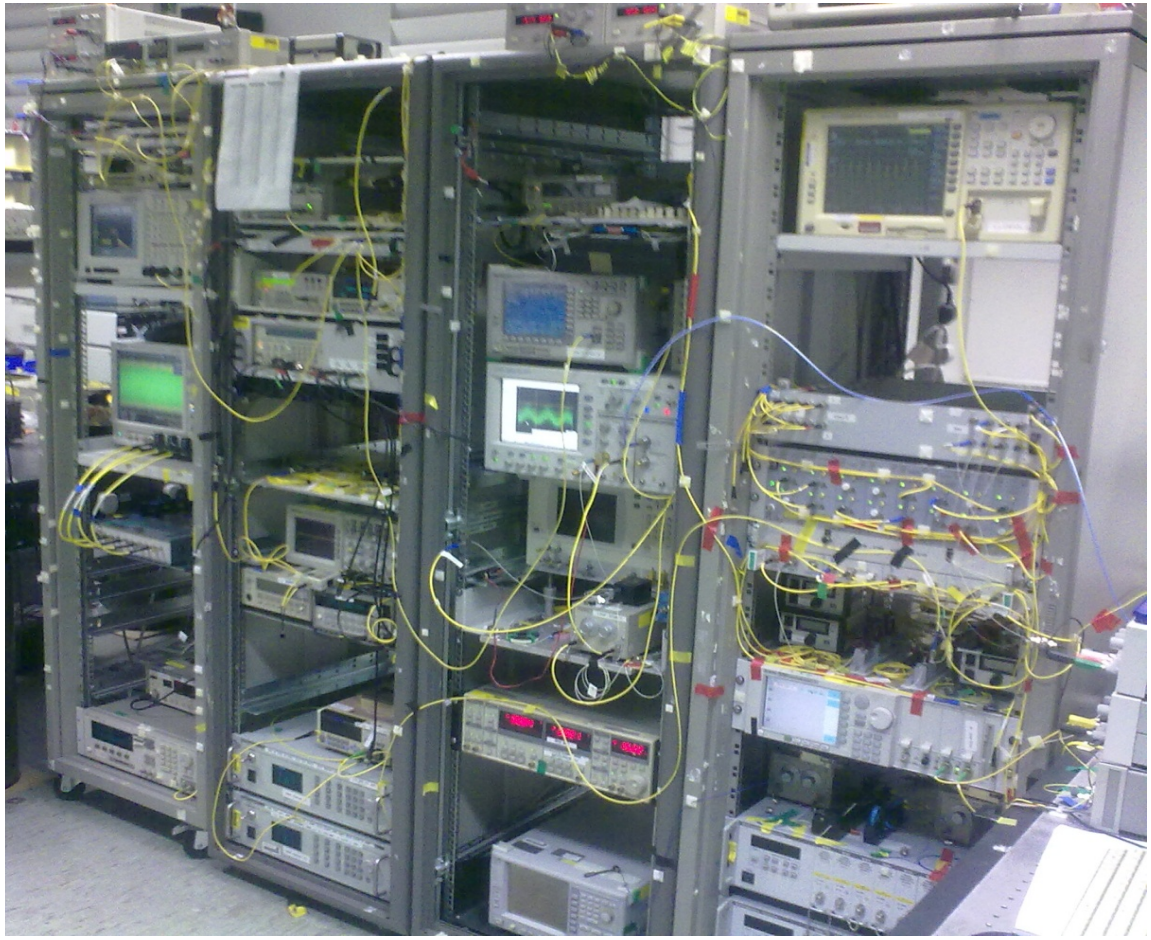
A diverse range of applications

–World class collaborative research addressing fundamentals and practical aspects of Communications & Connected Systems

Experimental facilities: Optical

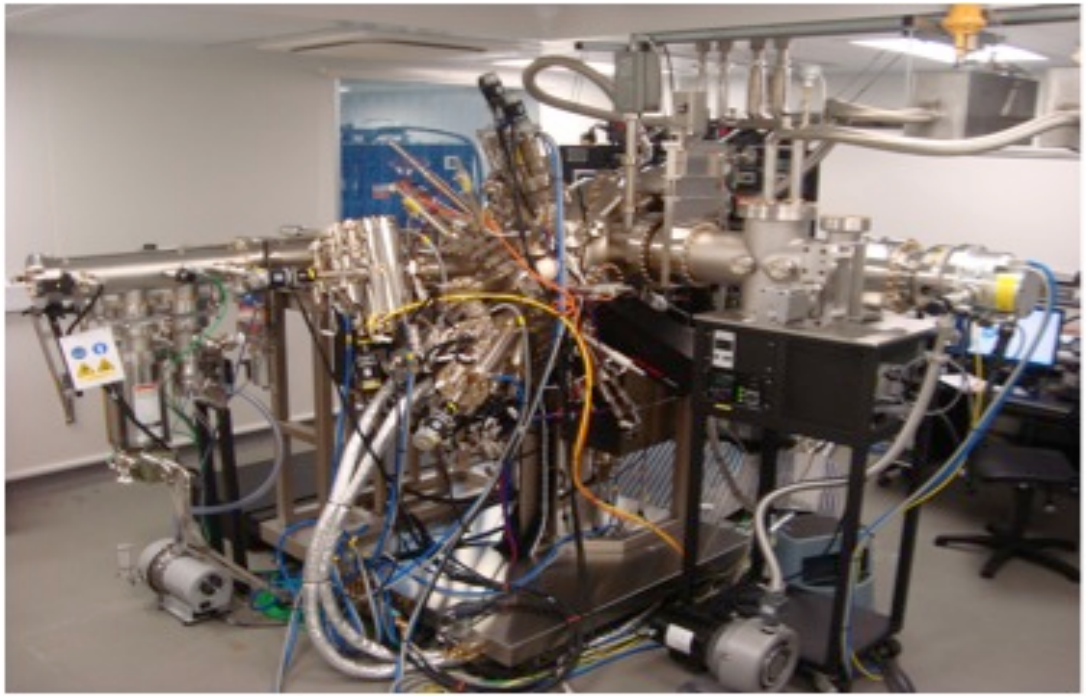
- State of the art labs
  - Allows for investigations up to 10,000km links
  - >300 Gbit/s per wavelength
  - Total capacity > 1 Tbit/s

- Facilities include
  - 32 λ WDM system
  - 50 GSa/s ADCs
  - 100GbE + signal generation
  - Digital coherent receivers
  - FPGA based transmitters



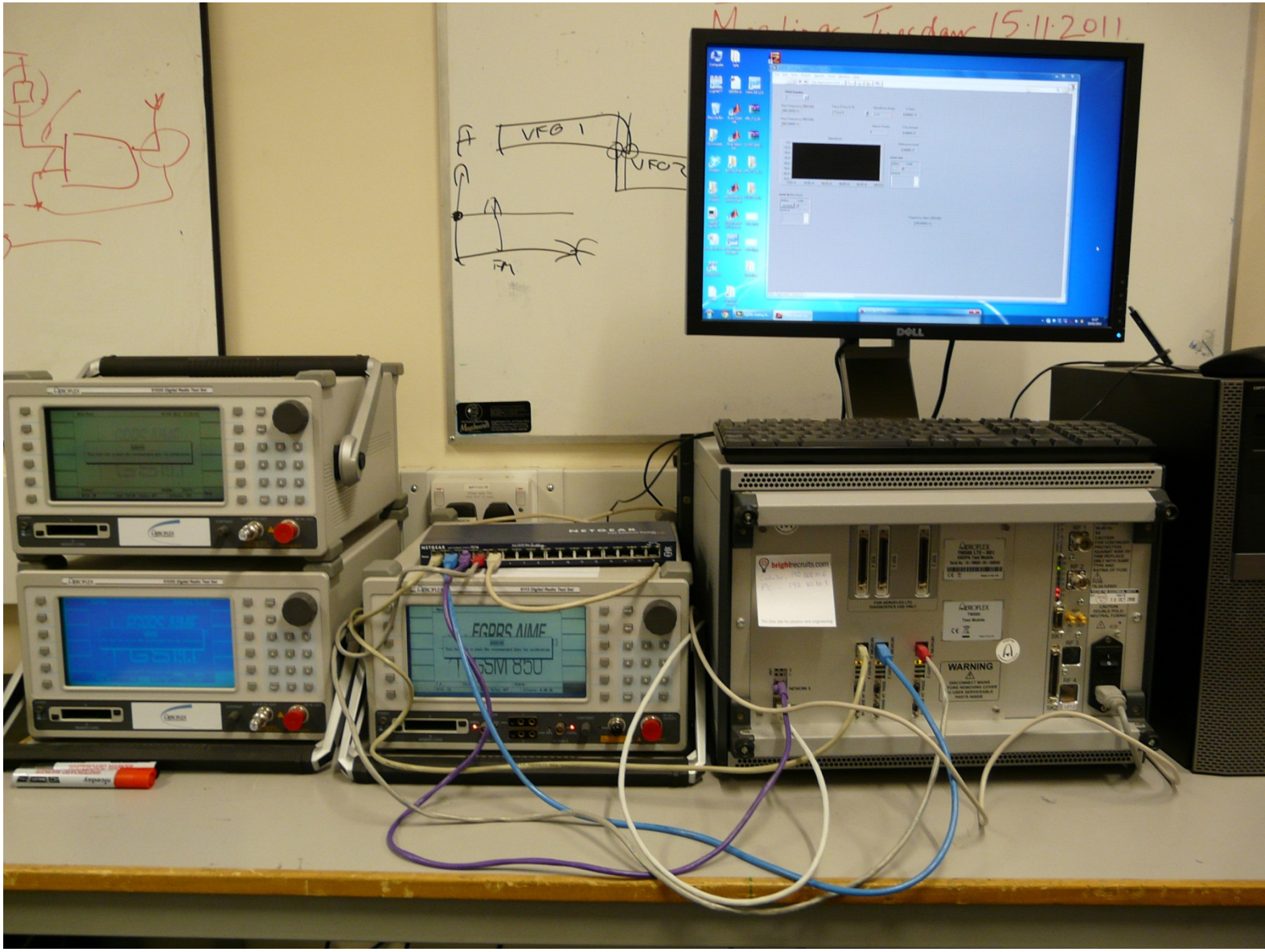
Facilities: Devices

- 4 laboratories for optical, high speed, RF and THz measurements
- 1 device characterisation lab
- 3 cleanrooms
- 2 Molecular beam epitaxy system

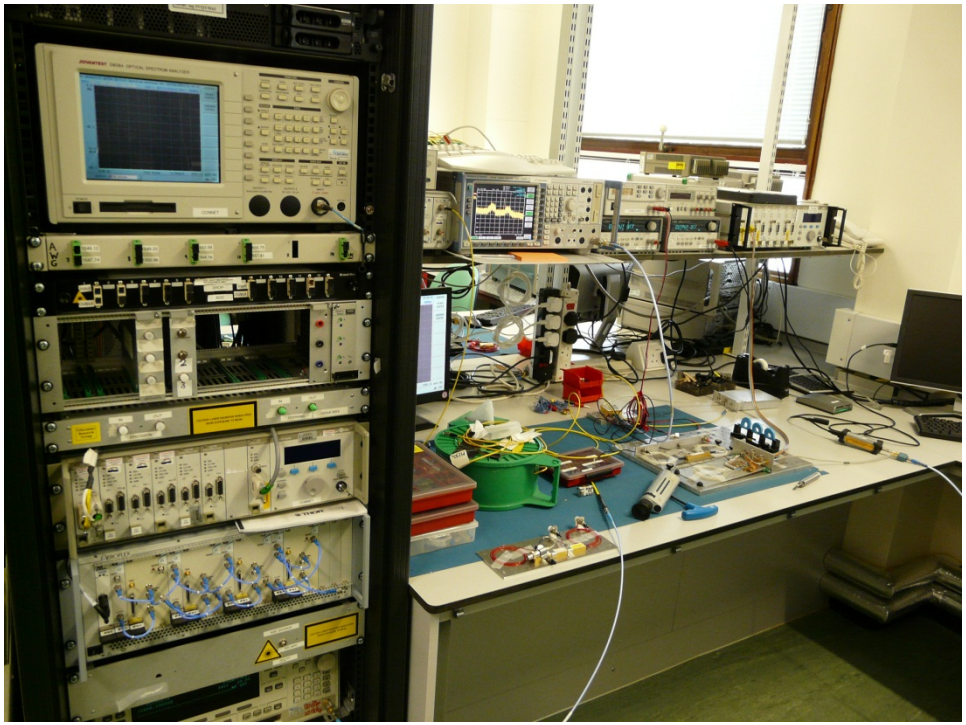


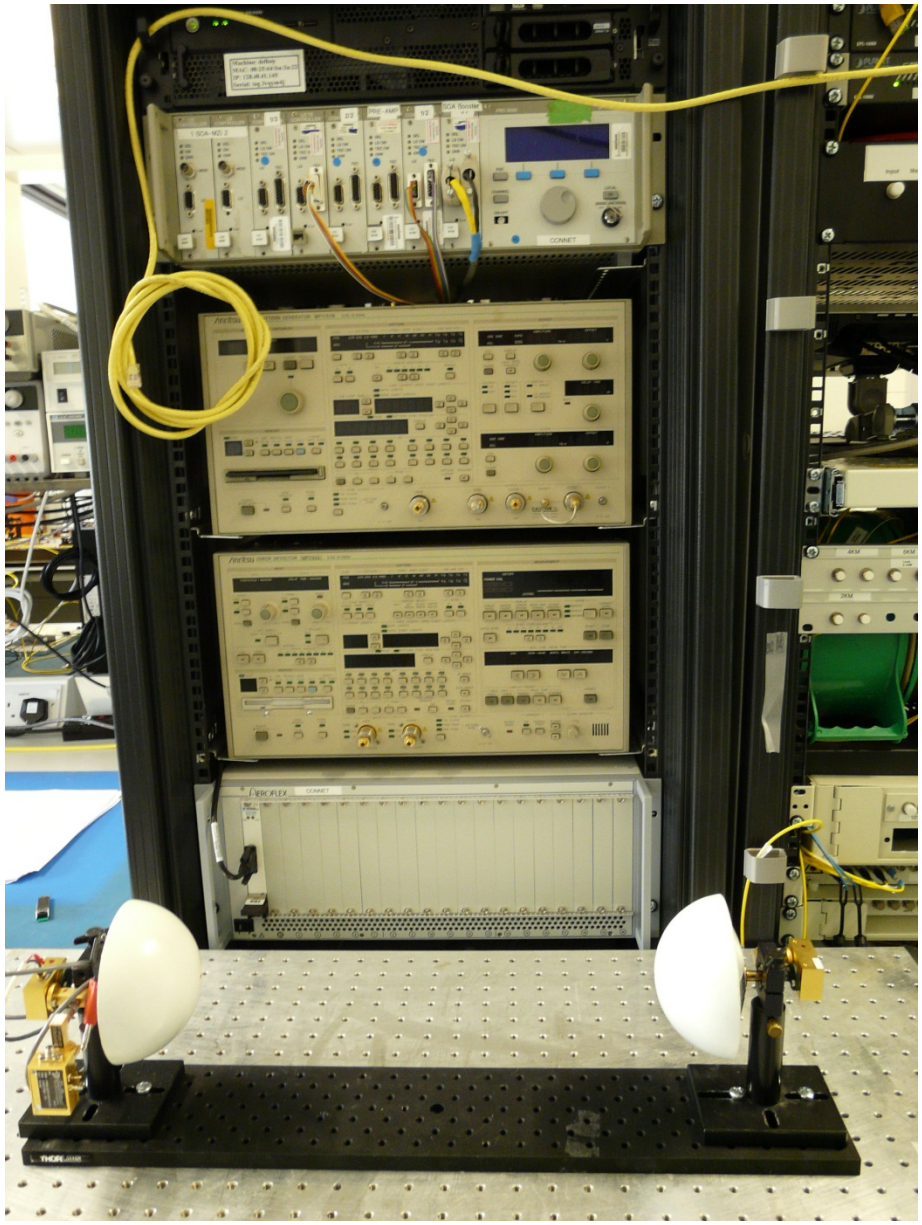
Experimental facilities: Wireless

- Bespoke FPGA



Experimental facilities: CONET (Wireless, optical and IP)





Need to attend lectures & tutorial.

Questions & discussion critical for MSc study.

Lecture files really meant as study support

The Tutorial is essential!

The tutorial is not a lecture.

The tutorial helps you towards the exam or assignment BUT only if you come prepared.

HOW TO BE PREPARED?

- You need to construct a personal study plan for each module.
- To get value from the tutorial you must have completed 60% of your Module revision.
- You must come to the tutorial with questions.

Doing research/writing assignments

What is involved that takes 50+ hours?

- the lecture material is an introduction to the important topics

- there are recommended texts to read and an excellent library at UCL

Internet sites with tutorial notes

Many journals and magazines, UCL access

- IETF has white papers

- equipment & software providers have white papers

It is your task to find information

Study Process

- Each module should take 80-100 hours of your time.
- Given 25 hours spent on the lectures and tutorial – this means 55 hours of supplementary reading and understanding the material ready for the Examination.
- Where the assessment is by Assignment, then a substantial part of this 55 hours will be focussed on discovering sources and constructing that assignment.
- Assignments (unlike exams) are never based on you answering a question nor they are based only on finding information. They are based on your own views on and synthesis of a specific issue, design, business case, software development..etc.

Marks and passing

- To pass you need 50%.
- Just passing is OK – but should not be your target.
- A mark in the 60s is very good performance (Merit) at this level and says you have drawn good benefit from the module.
- To get a distinction you need 70%.
- To graduate you need to have an overall average >50%, pass all modules (but allowed a maximum of two modules with marks 40%-50%) and pass the dissertation.
- The Examiners will be marking levels of understanding, supported by evidence – facts & examples.
- Assignments must include references to sources of evidence.

Plagiarism

- Why is it serious?
- What are exams and assignments for?
- Difference between discussion and cooperation, and collaboration.

www.ucl.ac.uk/current-students/study/plagiarism

- Collaboration on assignments is not allowed unless they are team projects.

ITN…What is it all about

UCL

To understand the basics of Telecommunications networks

- What?
  - Description (network and inside a network), structure, access and core, layers, signals and signalling, types, mathematics
- How?
  - Transmission, modulation, digital and analogue, control and intelligence, network design, internet and TCP/IP
- What for?
  - Services, wired and wireless, telephony, mobile and data wireless

–NETWORK

Will cover

General: Network fundamentals, Layers, services and regulation
Telephony: Network structure, switching, PCM, ISDN, ADSL.
Transmission: Basic principles, digital communications, modulation and coding
Internet technologies: Principles, Addressing, Subnets, DHCP, ARP, DNS, Routing, TCP, SIP and VoIP
Management and control: networks intelligence, services and SS7

Multimedia systems and IoT: Digital information signals and multimedia and IoT systems

- Professor Izzat Darwazeh

Director of ICCS and Professor of Communications Engineering
(transmission, Digital systems, wireless communications)

- John Mitchell

Professor of Communications Systems Engineering and Vice Dean EducationProfessor of Communications Engineering
(Fibre systems, PCM)

Professor George Pavlou

Professor of Communication Networks
(networking, network management and service engineering)

- Dr Laura Toni

Lecturer (multimedia systems)
(Multimedia, machine learning, coding)

- Professor Miguel Rio

Professor of Computer Networks (internet, QoS and IP applications)

How to do this module?

Job is divided between us and you…

- **We provide introductory knowledge through slides and words in lectures…(30%)**
  - **Not every thing is in the slides..lectures are important**
- **You have to do the hard work to translate these into deeper knowledge and understanding… (70%)**
  - **Not every thing is in the slides.reading, books, internet, papers are important**

The onus is on you

- **Need to do loads of thinking, reflection and most importantly reading**
- **Tutorial**
- **Exam**