Feasibility Study on a UK-China Open Access (B)4G Wireless Mobile Communication Testbed

Dr Xuemin Hong

(UC4G Shanghai Workshop, 12 September 2010)

Network Manager

UK-China Science Bridges on (B)4G (uc4g.eps.hw.ac.uk)

Research Assocaite

Joint Research Institute in Signal and Image Processing

Heriot-Watt University, Edinburgh, UK

Phone: +44-131-4514187

Fax: +44-131-4514155

E-mail: x.hong@hw.ac.uk

URL: www.eps.hw.ac.uk/~xh29/

Outline

I. Background

II. Proposal for a Link Level Testbed at the UK

III. Proposal for a UK-China Testbed Network

IV. Suggestions and Future Work

I. Background

- **UK-China Science Bridges: R&D on (B)4G Mobile Wireless Communications**
  - **Duration**: 3 years (01/08/2009-31/07/2012)
  - **Funding**: £1,174,258 (fEC) or £939,623 (RC contribution)
  - **A key objective**: Accelerate the deployment of research knowledge
  - Include 6 work packages
- **Work Package 4 (WP4): Wireless prototype/testbed development**
  - **Duration**: 21 months (01/08/2010-30/04/2012)
  - **Funding**: ~ £100k
  - **Motivation**
    - Enable proof of concept
    - Calibrate simulation results and steer R&D efforts
    - Identify and showcase advanced technologies
  - **Value and impact**
    - Facilitate technology transfer
    - Encourage commercialisation

Challenges of WP4

- **Limited funding**
  - Our budget: 100 thousand pounds
  - The German EASY-C project: 47 million euros
- **Shortage of man power**
  - No full time staff (partial commitments of a post-doc and 4 MSc students at HWU)
  - Lack of implementation experience
  - A testbed team in China can easily include tens of highly-skilled students
- **Researcher-friendly testbed**
  - Researcher usually have limited experience in implementation.
  - There is no mature solution yet for **rapid prototyping** of wireless systems.
- **Features of the testbed**
  - The WP4 testbed should aim to differentiate itself from existing testbeds.
- **Diverse testing demands v.s. limited testing capability**
  - It is difficult to clearly define the testing demands and match them to the testing capability.

Progress and Current Consensus

- **Additional resources**
  - WiCO and BUPT (etc) are willing to open (part of) their testbeds (SWAN and SORA).
  - Part of the WP2 funding can be used to support visits to set up the testbed at HWU.
  - Extra funding for testbeds is possible from. e.g., industry or EPSRC instrument grant.
- **Scope of the testbed**
  - Construction of a comprehensive new UK testbed is not a feasible option.
  - A simple, yet useful (possibly link level) testbed should be built at HWU.
  - The new testbed can be linked with other testbeds to form a **UK-China Testbed Network**.
- **Suggested areas to be tested**
  - User experience; Terminal software; Scheduling and QoS; Cooperative communications (relay, CoMP, network coding, backhaul and coding, etc); Green radio; Cognitive radio (carrier aggregation); Self optimising networks; Spatial modulation
- **Joint planning of WP4 with other WPs**
  - The testbed should be set up within 1.5 years, allowing 0.5 years to obtain results.
  - It is important to understand testing demands from the industry.

Outline

I. Background

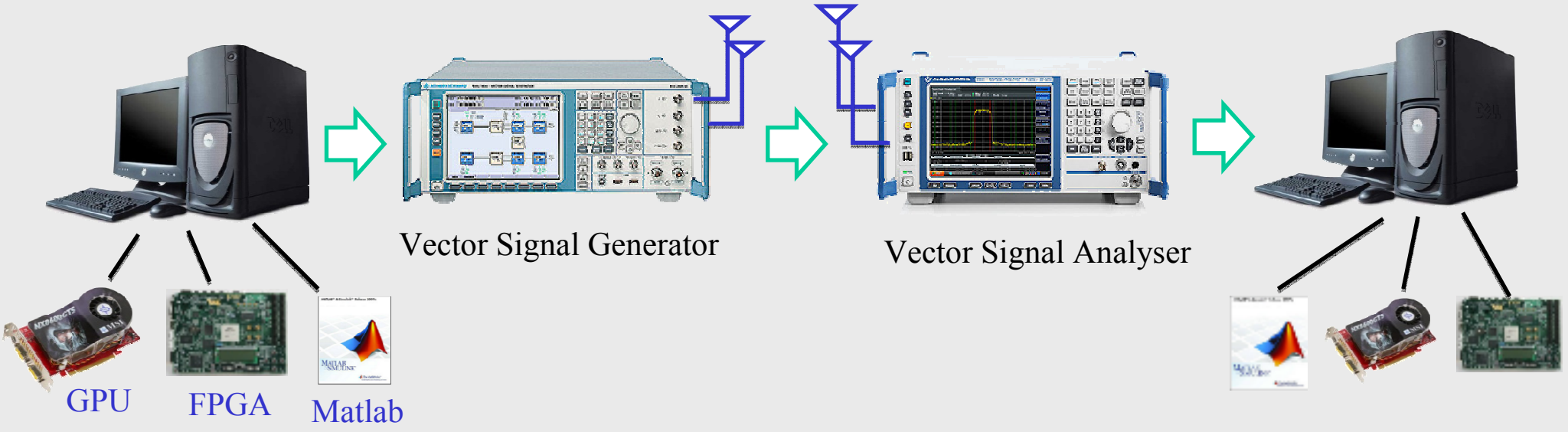
II. Proposal for a Link Level Testbed at the UK

III. Proposal for a UK-China Testbed Network

IV. Suggestions and Future Work

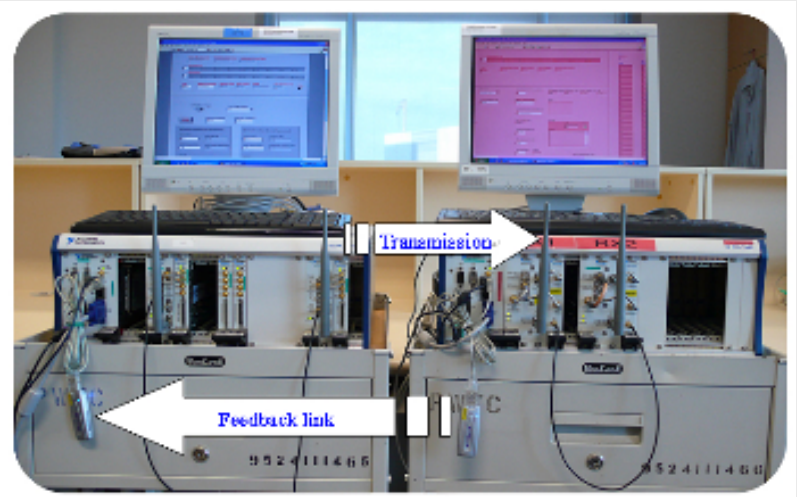
Solution 1: Standard Instruments

- **Build a testbed by integrating PCs and standard radio testing instruments**
  - Use standard instruments for RF signal generation and reception
  - Use PC workstations for baseband signal processing and control
  - Support off-line signal processing in Matlab
  - Adopted by WiCO



Solution 2: Modular Instruments

- **Build a testbed based on modular instruments**
  - Modular instruments for radio testing provide flexible and convenient integration of modular components for RF, baseband, and power, etc.
  - Compatible with Matlab; Complicated hardware design (e.g., HDL) can be avoided.
  - Suppliers include National Instrument (NI) and Aeroflex.
  - Adopted by WiCO

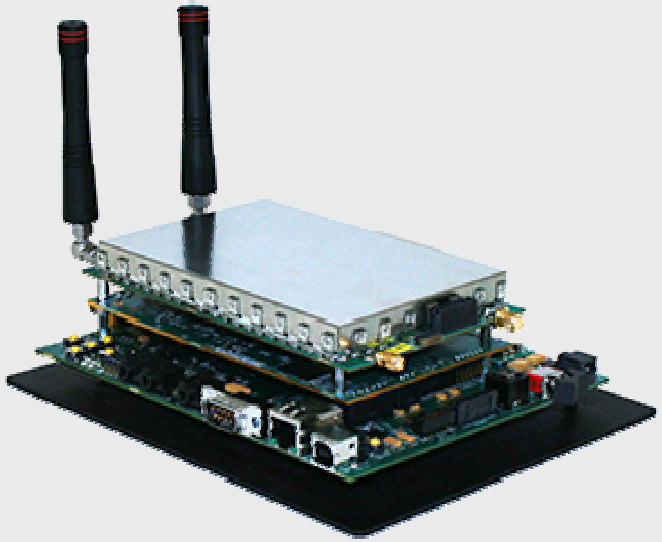


A NI instrument based MIMO-OFDM testbed at Nanyang Technological University, Singapore [http://www.pwtc.eee.ntu.edu.sg/Research/Pages/research_projects_mimo.aspx]

Aeroflex 3020 Series PXI RF Signal Generator

Solution 3: Commercial Testbed

- **Purchase commercial off-the-shelf testbeds**
  - Specialised companies sell commercial software define radio (SDR) testbeds including all components from baseband to RF.
  - Suppliers include Lyrtech and PenTek, etc.
  - The state-of-the-art products can support processing capability equivalent to 1 WiMax BS and 4 GSM BS.

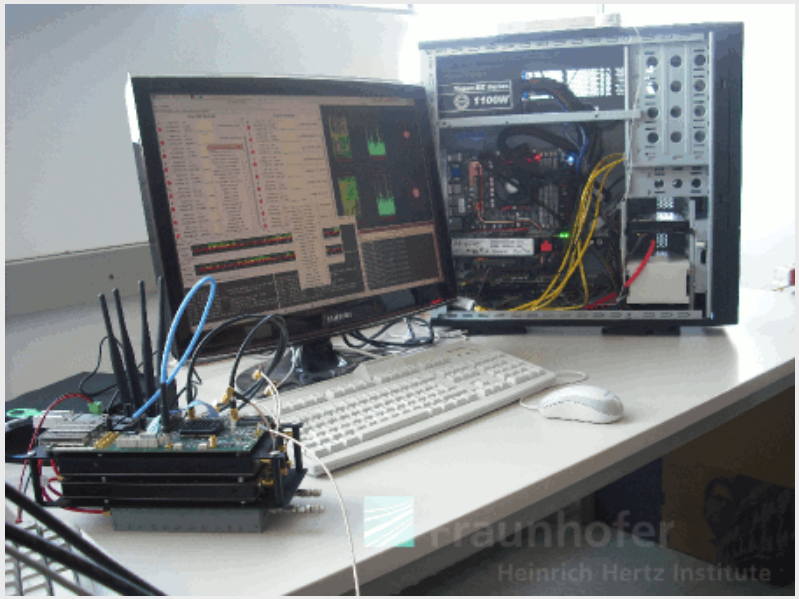


Lyrtech SDR development platform
(www.lyrtech.com)

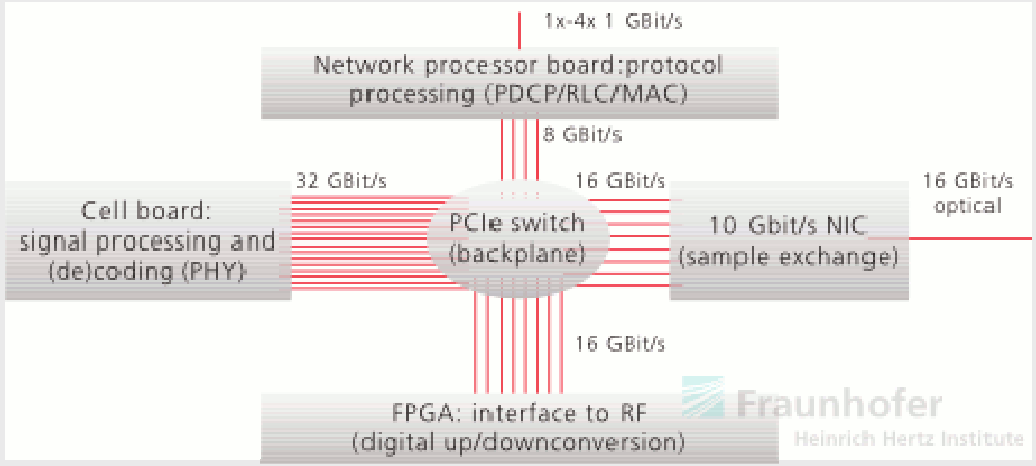
PenTek 7142-428 SDR platform
(www.pentek.com)

Solution 4: Integrated Testbed

- **Integrate the testbed based on commercial off-the-shelf subsystems**
  - Off-the-shelf baseband, RF, and data acquisition subsystems can be purchased and integrated to build a testbed.
  - Different subsystems are commonly integrated through PCIe or PXI interfaces.
  - Adopted by Heinrich Hertz Institute (HHI), Germany



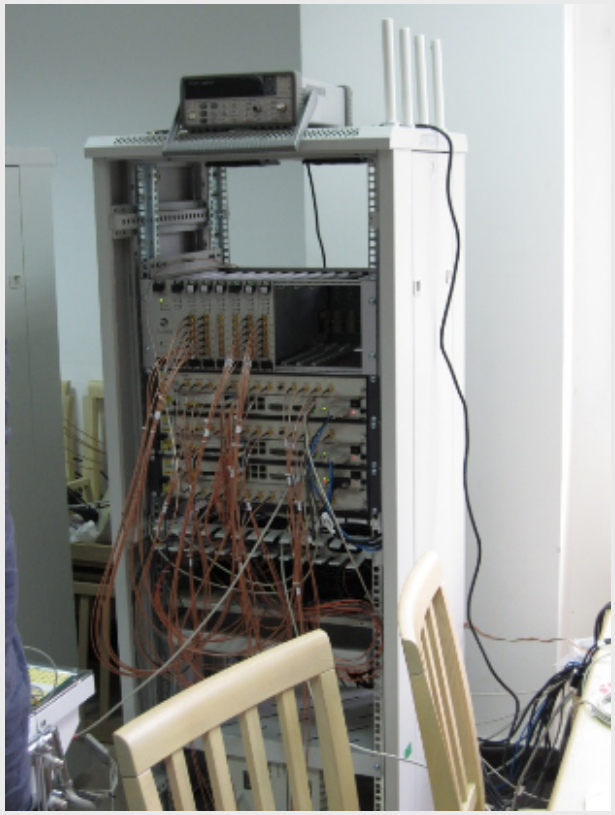
A SDR testbed at HHI, Germany
(www.hhi.fraunhofer.de)



Architecture of the SDR testbed at HHI, Germany
(www.hhi.fraunhofer.de)

Solution 5: Self-designed Testbed

- **Design and produce customised testbed**
  - Design subsystems from baseband to RF and produce highly customised testbed
  - Adopted by Southeast University, China



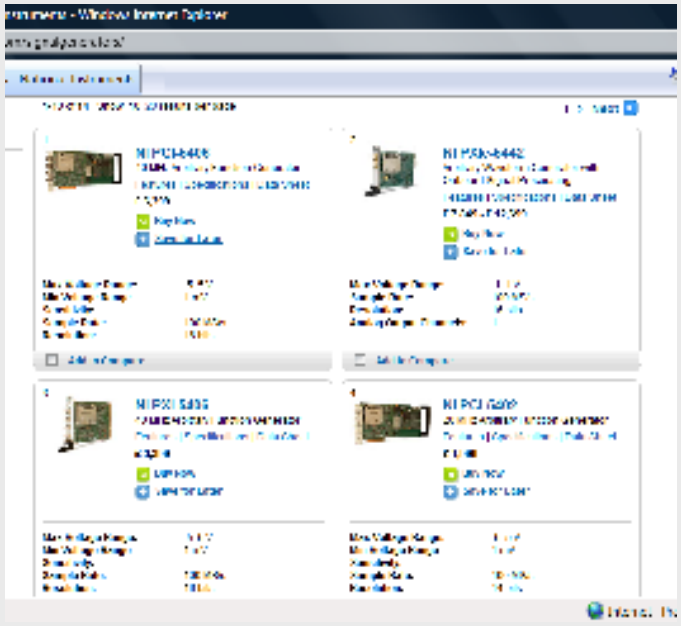
A Gbps transmission testbed at Southeast University, China

Pros and Cons of Various Solutions

	Performance (e.g, bandwidth, real-time)	Flexibiity (e.g., spectrum, power)	Development Efforts	Cost
1. Standard Instrument	Low~Medium	Low~Medium	Low	Medium
2. Modular Instrument	Medium	Low~Medium	Low	Medium
3. Commercial Testbed	Medium	Low	Low	Medium~High
4. Integrated Testbed	Medium	Medium~High	Medium	Medium
5. Self-designed Testbed	High	High	High	High

A Scalable Way Forward

- **Advantages of modular instruments**
  - Open architecture to allow flexible system configuration (e.g., MIMO, bandwidth, centre frequency, baseband processing methods, etc.)
  - Scalable hardware architecture to allow system upgrade (e.g., SISO to MIMO)
  - Capable to support real time



Diverse options for signal generators

Scale a system based on building blocks

Outline

I. Background

II. Proposal for a Link Level Testbed at the UK

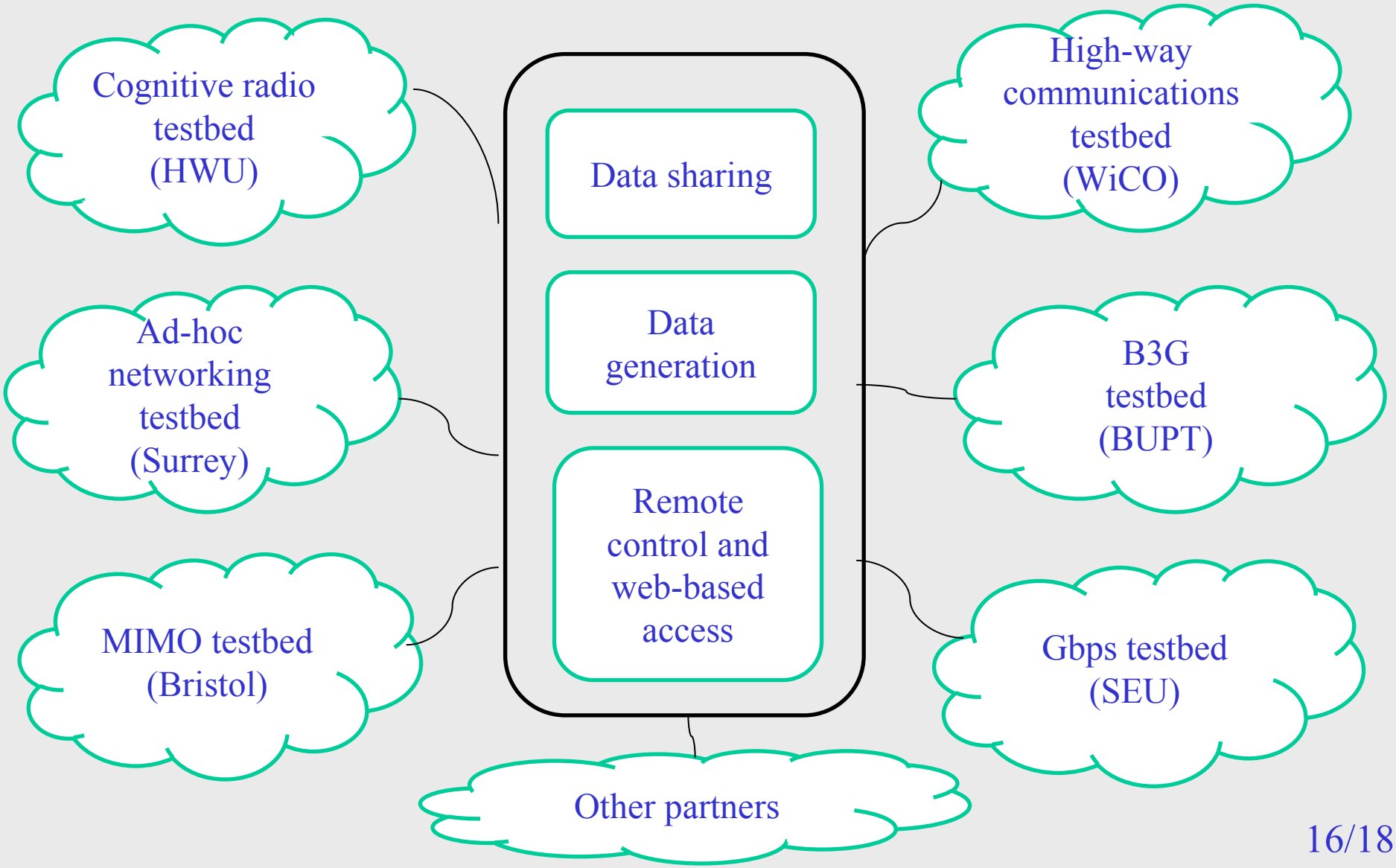
III. Proposal for a UK-China Testbed Network

IV. Suggestions and Future Work

A UK-China Testbed Network

- **There are many (both large and small scale) testbeds in the UK and China**
  - Cover various layers and different scenarios (micro-cell, high-way, femto-cell, etc.)
  - Have different features
  - Some testbeds support remote access and control, e.g., SWAN in WiCO
- **A testbed network that integrates various distributed testbeds**
  - **Feature-based integration**
    - A pool of different distributed testbeds that support different testing features (e.g, scenarios, technical areas).
  - **Data-based integration**
    - Share (offline) data among testbeds (e.g., PHY layer testbed + MAC layer testbed).
  - **Internet-based integration**
    - Testbeds that support remote control can be integrated via Internet.

Illustration of Concept



Summary & Future Work

- **Summary**
  - We have to set up a testbed and we have very limited budget and man power.
  - It is important to understand current demands for testbeds in academia and industry.
  - It is important for the new testbed to differentiate itself from the many existing ones.
  - Possible way forward for a link-level testbed: based on modular instruments.
  - To establish a Testbed network is attractive.
- **Future work**
  - Seek wider opinions from academia and industry regarding the UC4G testbed.
  - Visit BUPT, and possibly other UC4G partners.
  - Draft a testbed feasibility study report.

?

Thank you for your attention!

Dr Xuemin Hong

Network Manager, UC4G Project
Post-doc Research Associate
Joint Research Institute of Signal and Image Processing
Department of Electrical, Electronic, and Computer Engineering
Heriot-Watt University, Edinburgh, EH14 4AS, UK
Tel: +44-131-4514187
Fax: +44-131-4514155
Email: x.hong@hw.ac.uk
URL: www.ece.eps.hw.ac.uk/~xh29/