工業技術研究院
Industrial Technology Research Institute

Proposal Ideas for EU-Taiwan Targeted Opening Call

Ching-Tarng Hsieh
ICL/ITRI

工業技術研究院
Industrial Technology Research Institute

EU-Taiwan Cooperation on 5G

- ICT-08-2017 (part b) : 5G PPP Convergent Technologies
- Scope : Cooperation in access convergence

  This activity takes advantage of the supporting 5G research and demonstration facilities offered by Taiwan towards collaborative 5G research with the EU, and aims at developing and demonstrating an integrated convergent access across different air interface technologies and the fronthaul/backhaul/core network. Test beds making use of facilities offered by Taiwanese partners are targeted. It demonstrates the capabilities of new spectrum access schemes, including for co-working with the network. A system demonstrator showing applications potential is thus favoured, e.g. for high speed moving vehicles.
- Type of funding : Research and Innovation Actions (RIA)
- Level of Funding : €5 million

工業技術研究院
Industrial Technology Research Institute

ICT-08-2017 Call Information

- Call Opens : 10 May 2016
- Call Closes : 08 November 2016
- Team composition:
  - At least 3 organizations from different EU member states
  - At least 1 participant from Taiwan and is funded by the Taiwan government
  - Industry driven activity considered as key
- Proposal evaluation : two evaluators each from EU and Taiwan
- Number of projects expected : 2

工業技術研究院
Industrial Technology Research Institute

6 Proposal Ideas

1. 5G RRH Platform, OTA Measurements and Multi-RAT Deployment Tool
2. Highly Coordinated Ultra Dense Network
3. 5G Mobile Edge Computing
4. Integrated Convergent Access for Massive MTC in Factories of the Future
5. Convergence of 5G/IoT/G5* for the SeaPort Of Things
6. Real-time virtualization infrastructure for NFV applications

工業技術研究院
Industrial Technology Research Institute

Project Scope

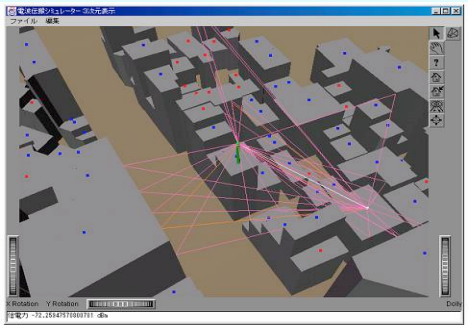
- The project scope includes mmWave radio channel measurement & channel modeling, development of network planning tool, and a 5G RRH testbed.

Channel Measurement & Modeling

- To model channel properties on mmWave bands, including
  - *28GHz & 38GHz*
  - *Shadowing and blockage effect due to foliage, human and vehicle*

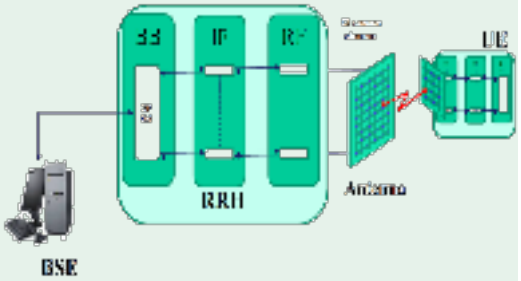
Network Planning Tool

- To develop a multi-RAT (LTE & 5G) network planning tool including a two-tier architecture
  - *Low frequency system (macro + small cells)*
  - *mmWave small cell system*



5G RRH testbed

- To verify the accuracy of the network planning tool
  - *Large Phased Array Antenna (16x4)*
  - *28 GHz center frequency*
  - *280MHz system bandwidth*
  - *TDD operation, 8.4Gb/s*
  - *Beamforming*



工業技術研究院
Industrial Technology Research Institute

Highly Coordinated Ultra Dense Network

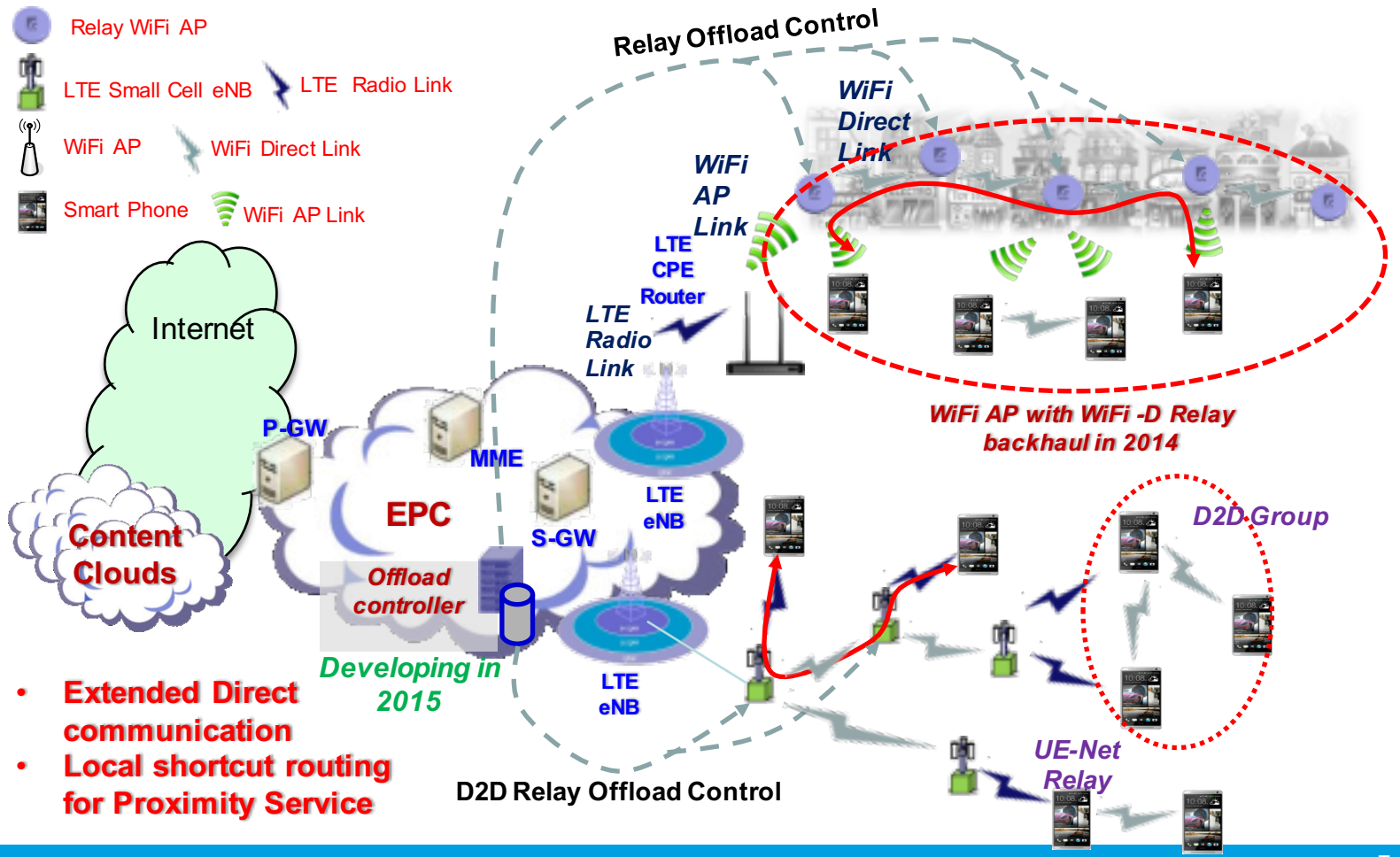
- **Objective**
  - Design ultra dense mobile networks that increase the total areal traffic capacity linearly with the number of small cell base stations in the area
- **Overall Strategy**
  - Focus on using the Network MIMO technology for interference mitigation and interference exploitation
  - Work with EU partners to explore different dimensions and different design points in the design space, and compare the results on the same platforms.

– **Technology Uniqueness**
  - **Network MIMO**: Implement C-RAN based tight coordination in UDN. Compute Pre-coding matrix for Coordinated beamforming and Joint Transmission to eliminate interference.
  - **Functional Split**: How to split the RAN functionality between central controller and geographically distributed base stations
  - **Channel Prediction**: Use historical and current channel information to predict channel state, and then eliminate interference between BSs
  - **Inter-Base Station Synchronization**: Tight synchronization of the transmission frequency of neighboring base stations

5G MEC Network

Shopping mall test bed | **High speed rail test bed** | **Telecom Italia**

IoT	V2X	Smart phone	Edge Cloud

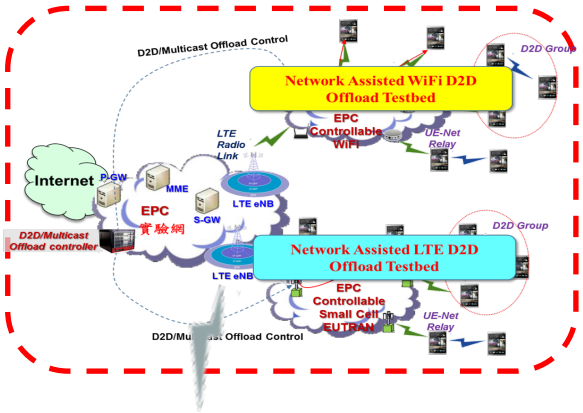


- **Extended Direct communication**
- **Local shortcut routing for Proximity Service**

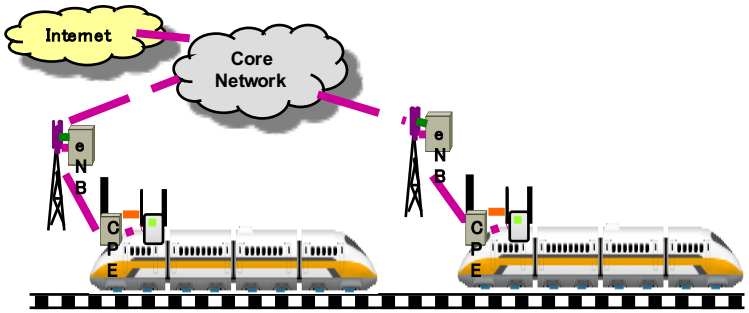
工業技術研究院
Industrial Technology Research Institute

Test Beds of 5G MEC Network

- Shopping Mall
  - Static Edge Network



- High Speed Train
  - Moving Edge Network



工業技術研究院
Industrial Technology Research Institute

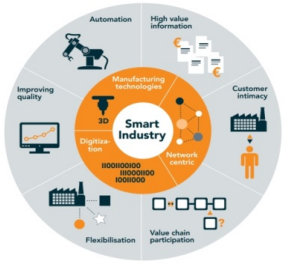
Cellular-based Network Architectures for Supporting MTC Services

財團法人資訊工業策進會
INSTITUTE FOR INFORMATION INDUSTRY

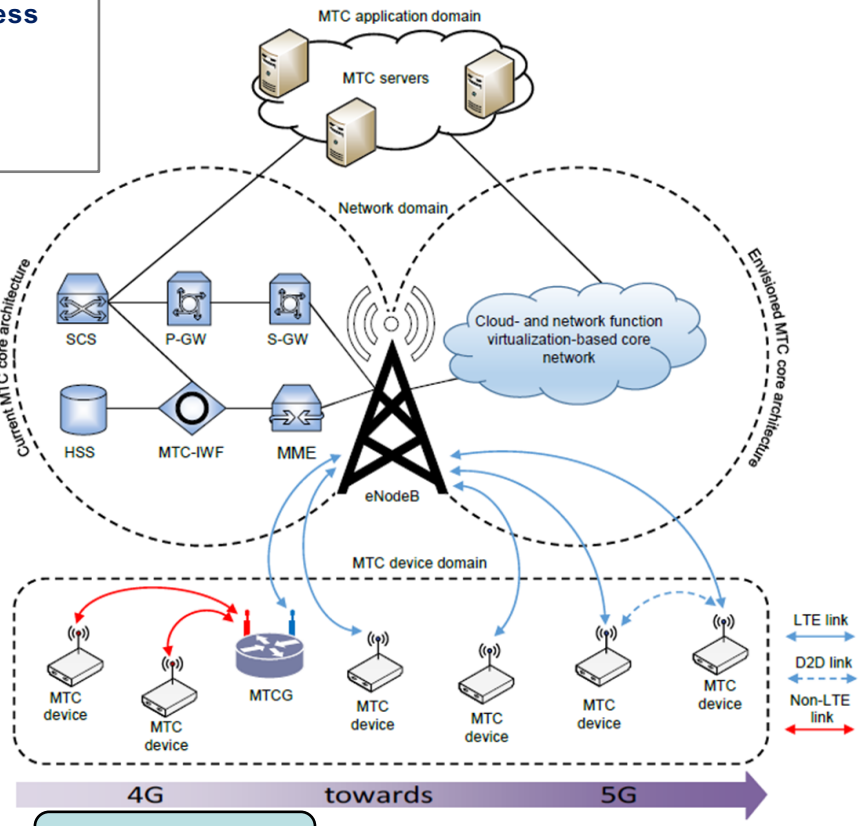
Dynamic Spectrum Sensing-based Transmission and Access
- Two-tiered Spectrum Repository
- Short-interval Auction for LSA
- Multi-Channel MAC ADR Platform
- 5G Spectrum Sharing SDR Platform

New Air Interface for MTC
Frame Structure Design
New Waveforms for MTC
Non-coherent modulation and demodulation for MTC
Non-orthogonal multiple access for MTC
Physical layer security for MTC

New MAC Protocol for MTC
Random Access Enhancement
Hybrid MAC Protocol
Cross-layer IoT Traffic Management



Source: smart industry (Dutch)



Non-time-critical in-factory communication

Internet of Machine Tools
- variety of controllers

Time-critical in-factory communication

Intelligent MT Production Line
- variety of vendors

工業技術研究院
Industrial Technology Research Institute

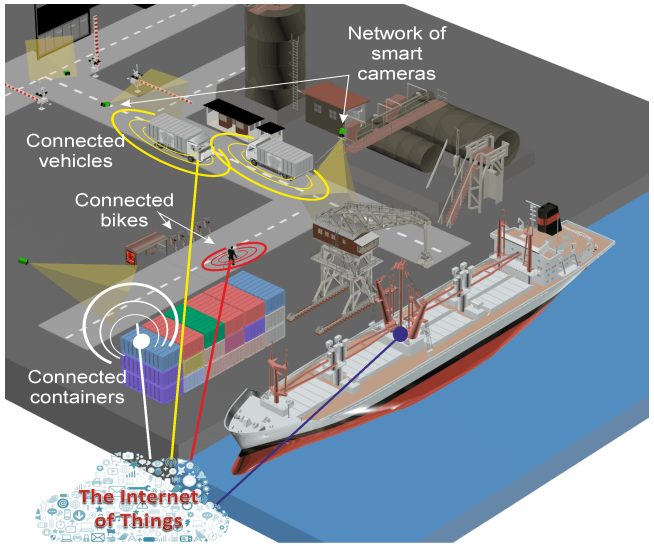
Convergence of 5G/G5 for the SeaPort Of Things

- **Develop 5G/G5* access convergent technology for operation at seaports**
  - **Efficiency**
    - **Support HD Video inspection for operations at wharf area**
    - **High bandwidth requirement**
  - **Safety**
    - **Avoid vehicle collision (e.g. trucks, stackers) at yard area**
    - **Ultra low-latency requirement**

- **Deploy testbeds at Taiwan and EU major seaports**

EU

Taiwan



* G5 (or ITS-G5) stands for the DSRC spectrum for ITS purposes in Europe

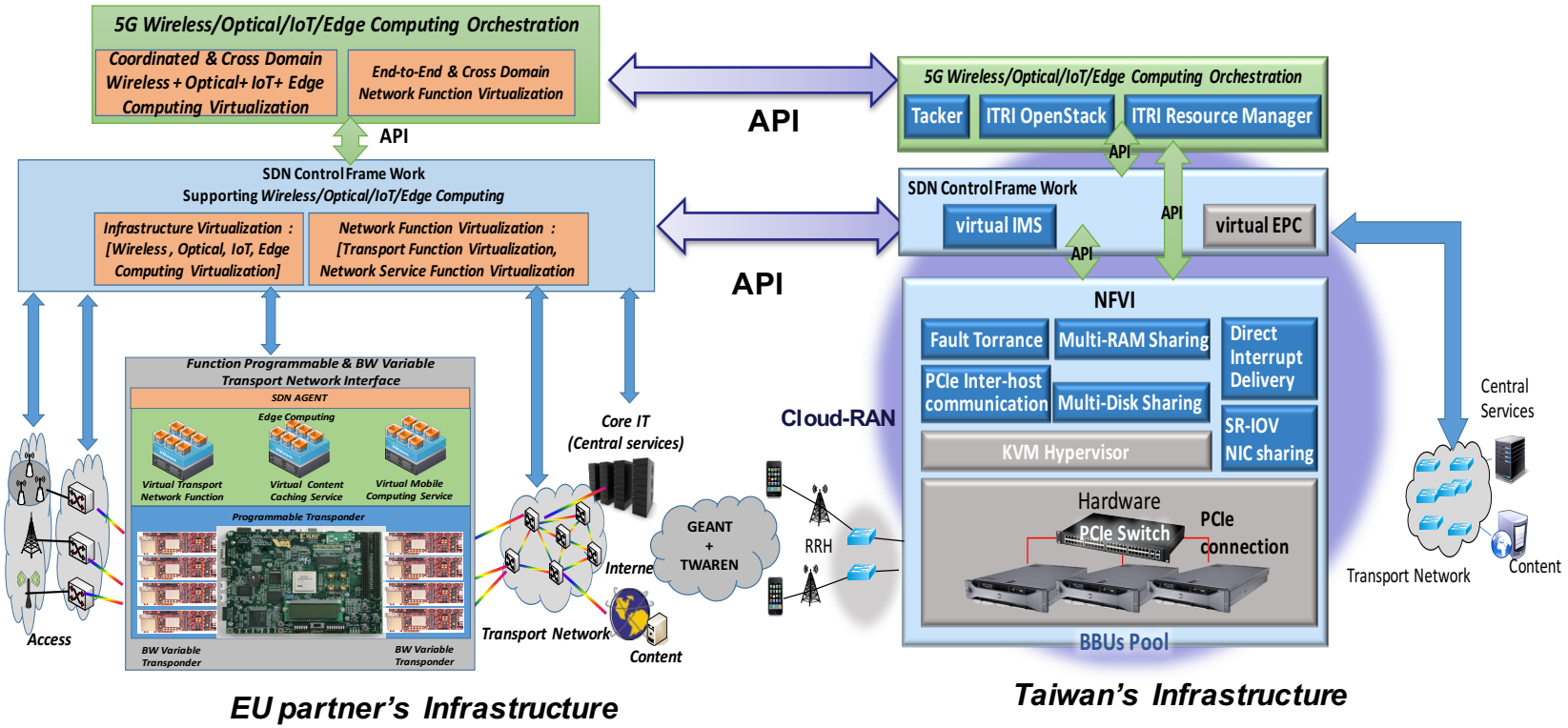
工業技術研究院
Industrial Technology Research Institute

Real-Time Virtualization Infrastructure for NFV applications

- Sophisticated optimizations and diversified application requirements demand a 5G network function processing platform that is highly flexible and efficient
  - NFV come into play
- NFV requires a virtualization platform that is **qualitatively** different from cloud-based virtualization platform
  - Low latency
  - Real time
  - Seamless fail-over
  - VM group-based seamless fail-over
  - VM group-based load balancing and auto-scaling
- Goal: Flexibility of virtualization but none of its overhead
- Target test bed: Tele-operated drone using ITRI NFVI and ITRI's experimental cellular network

工業技術研究院
Industrial Technology Research Institute

EU- Taiwan: Intercontinental demonstration and test-bed for the proposed concept



Thanks for your attention!

Ching-Tarng Hsieh
chsieh@itri.org.tw