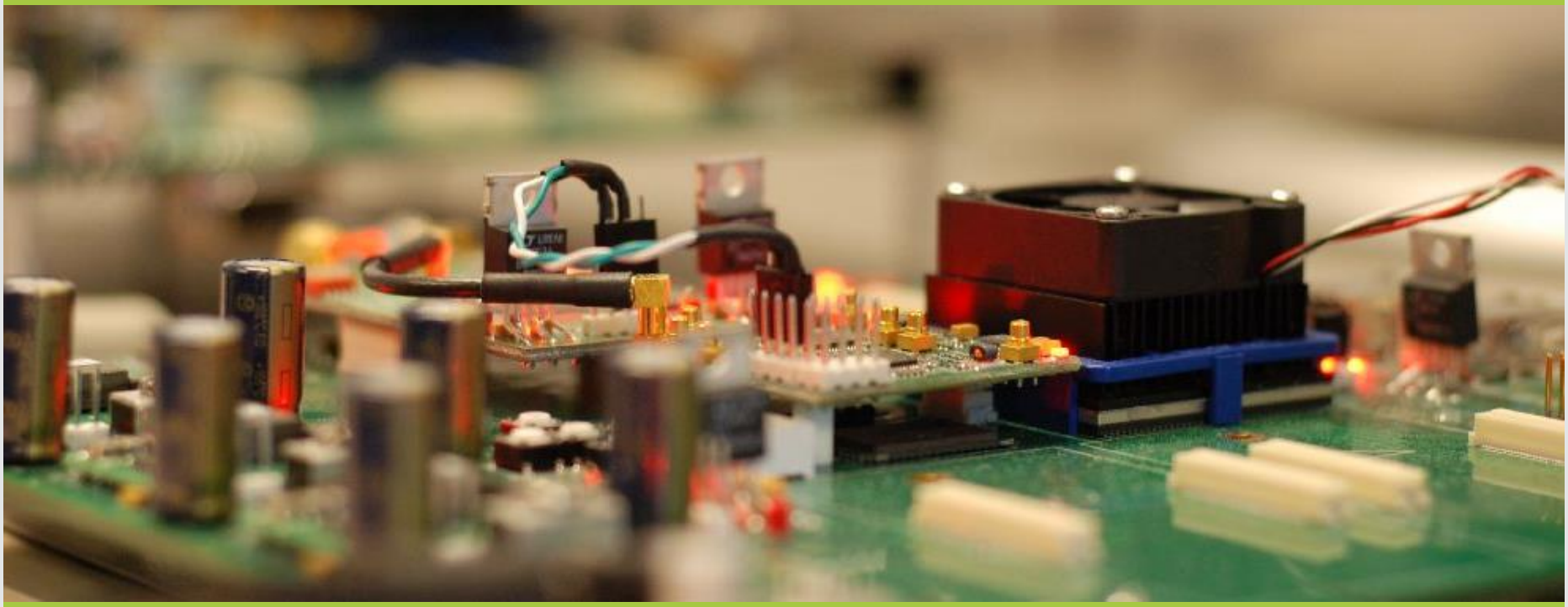


Scandinavian workshop on testbed based wireless research

CWC Wireless Networking Lab 2014

Tuomo Hänninen

CWC's Wireless Networking Lab?

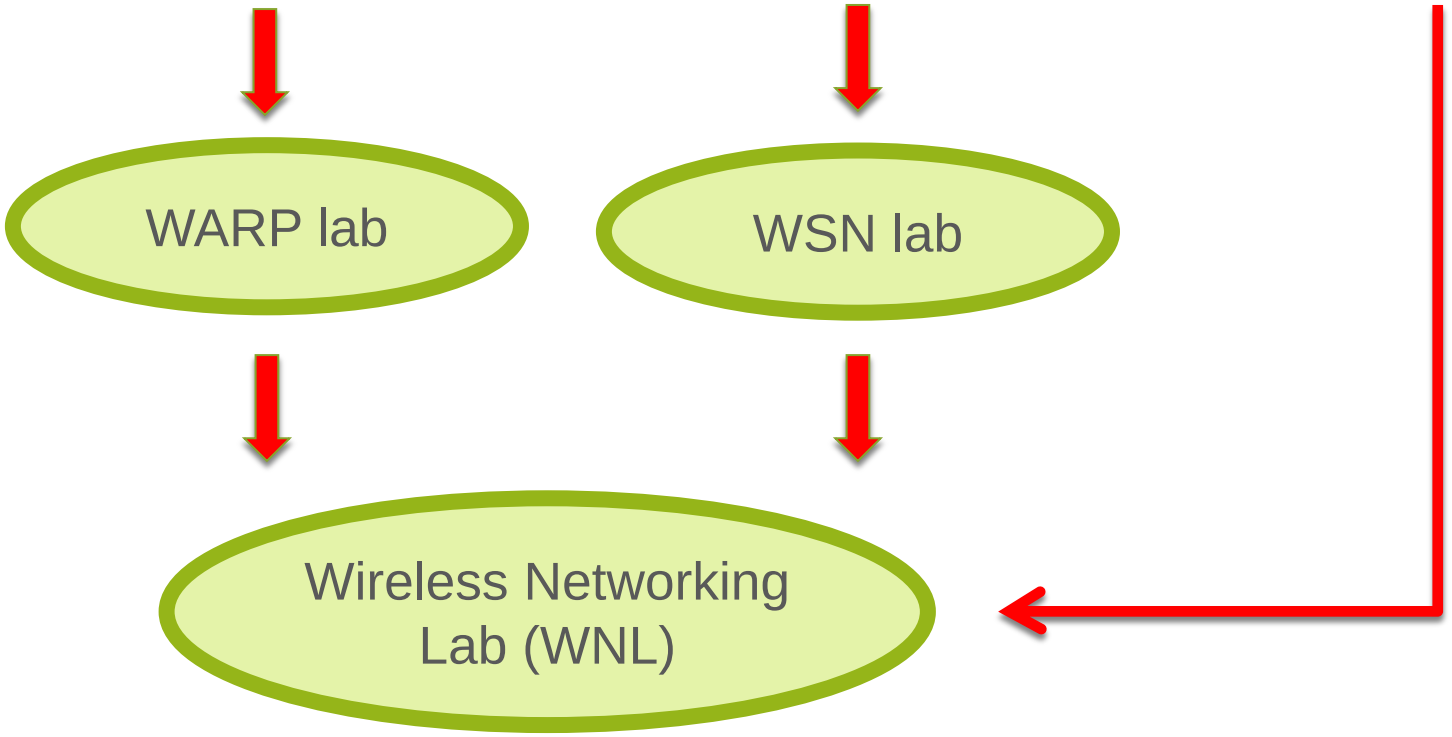
- Will be established in 1.1.2014 →

CWC's Wireless Networking Lab?

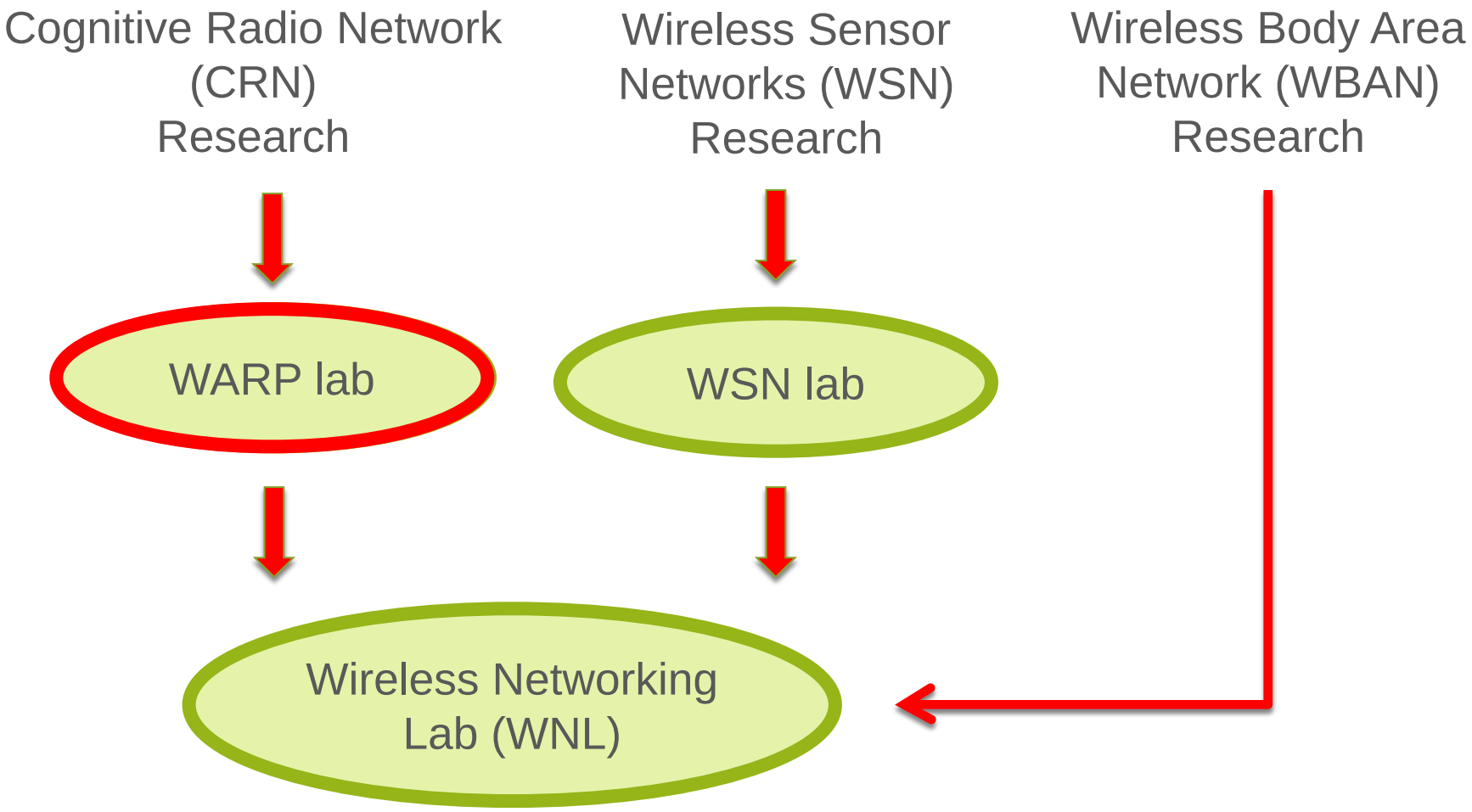
Cognitive Radio Network (CRN) Research

Wireless Sensor Networks (WSN) Research

Wireless Body Area Network (WBAN) Research



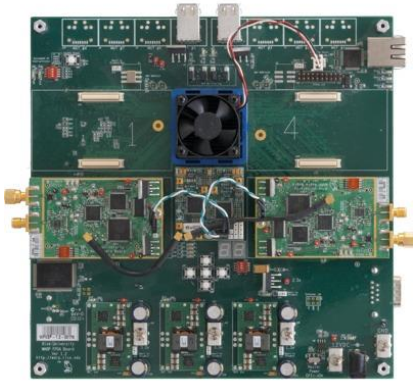
WARP lab



WARP lab

What do we have?
WARP

- Programmable wireless research platform
  - FPGA to fabricate PHY layer algorithms
  - CPU to program MAC layer protocols
- CWC Linux enriched design (LE-WARP) to support NET layer
- Mainly for network level research (at CWC)
- WARPlab framework for rapid development of physical layer algorithms



WARP lab

What do we have?

Xilinx ML605 + Nutaq 420X Radio card

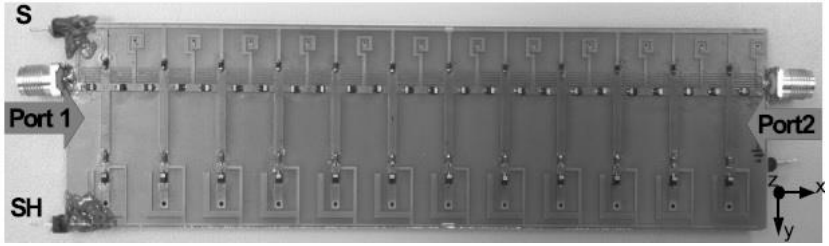
- The Radio420X card connected with FMC to ML605
  - SISO / 2x2 MIMO
  - Wide frequency range: 300MHz to 3 GHz
  - 1,5MHz to 28MHz BW
- WARPLAB type design developed for this hardware
- For link-level research

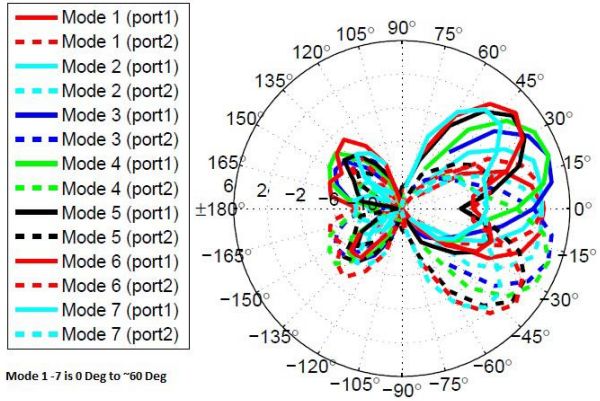
WARP lab

What do we have?

Reconfigurable Leaky Wave Antenna

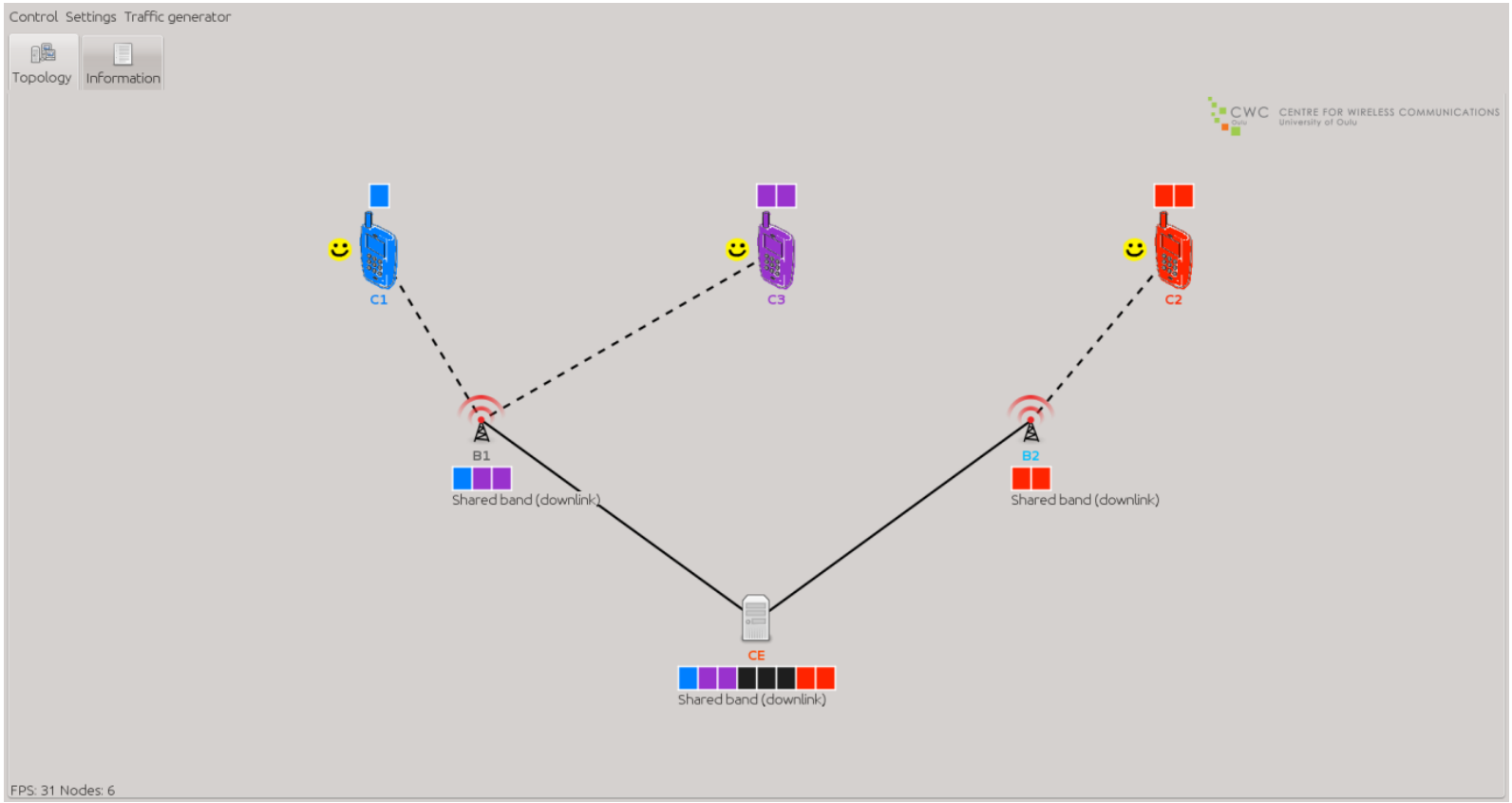
- RLWA is a two port antenna designed to electronically steer two directional beams over a wide angular range (+60°, -60°)
- Can be used with WARP system on 2,4GHz band
- Controlled with voltages between 0 V to 32 V





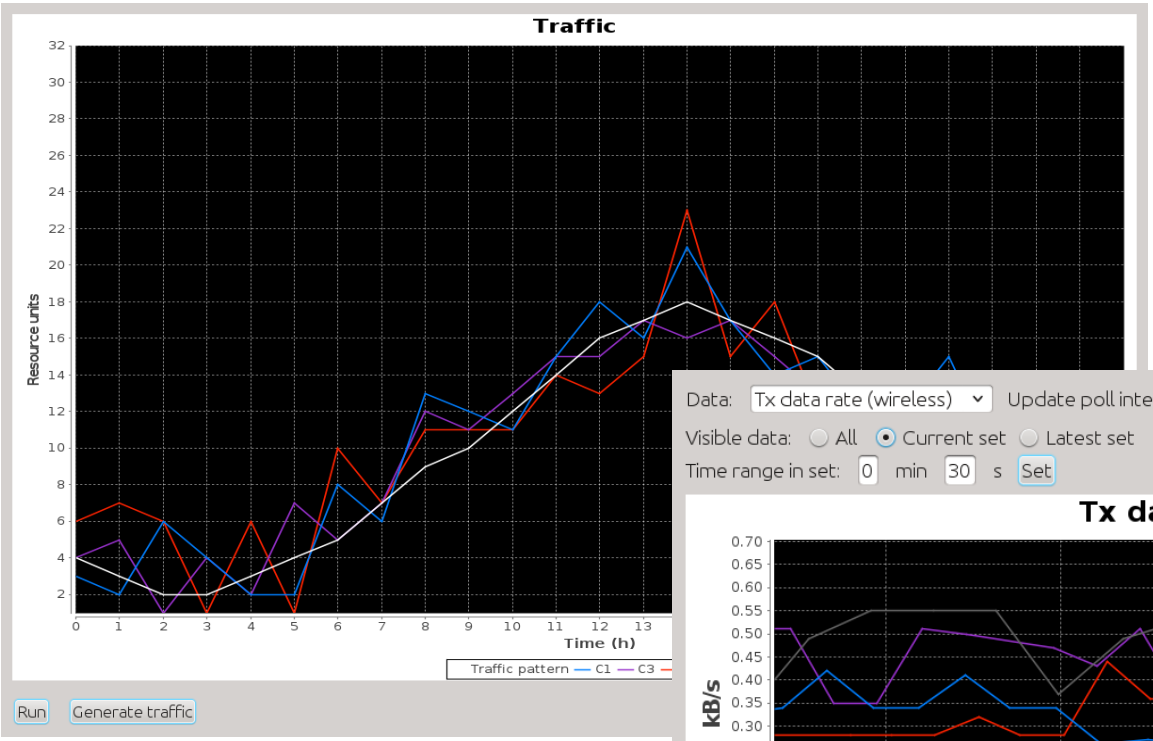
WARP lab

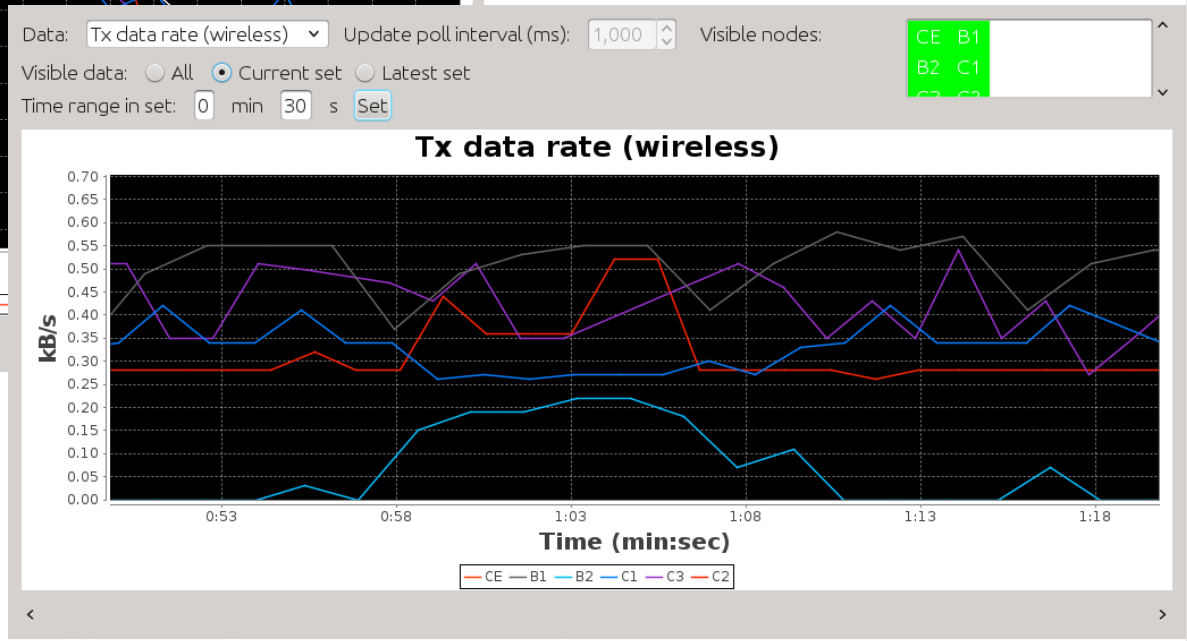
Graphical User Interface (GUI)



WARP lab

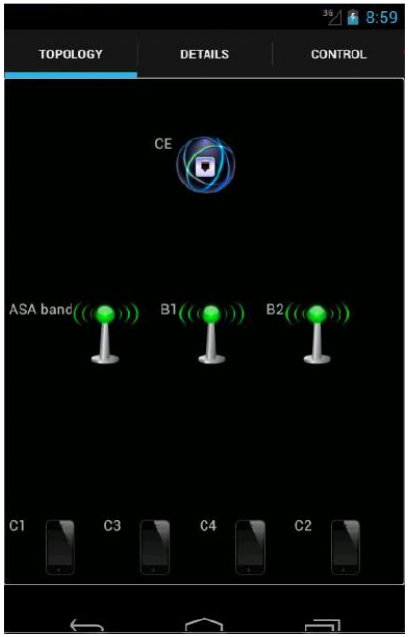
Traffic generator

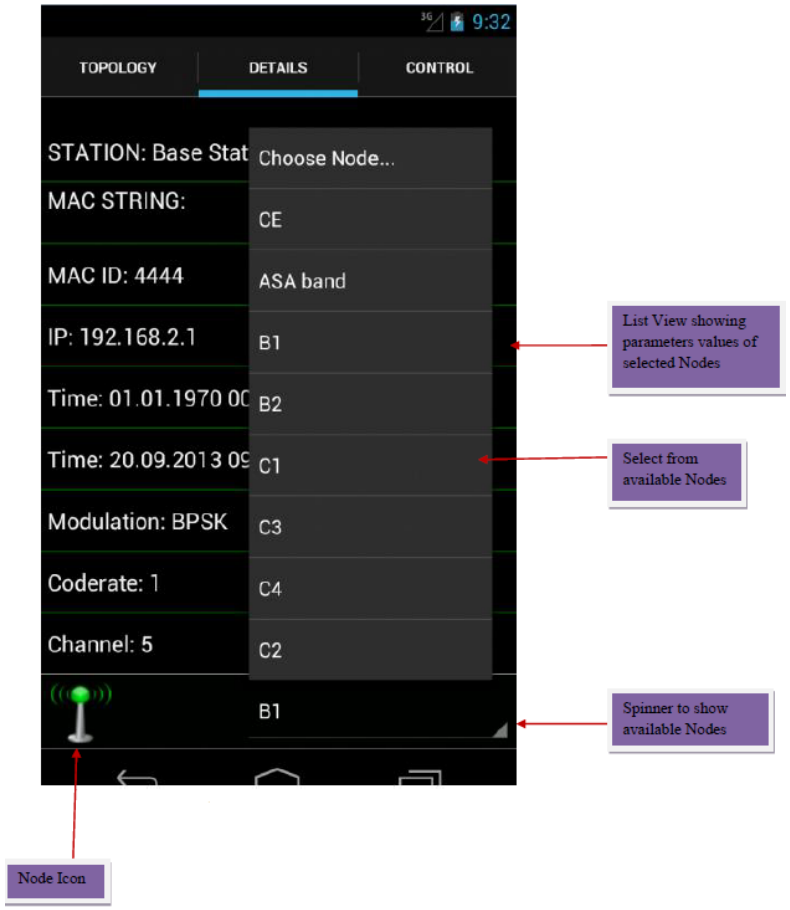




WARP lab

Android version of GUI





WARP lab

What have we done?
Consepts (1/2)

- CWC CORE Trial Environment
  - For prototyping cognitive engines & algorithms in real time over the air environment
  - Benefits Of Cooperative Offloading In Cognitive Radio Networks, 12th FRUCT Conference, Oulu 2012
- Cognitive Radio Assisted Mobile Ad Hoc Network (CRAMNET)
  - In MobiCom 2010 Chicago, Best Demonstration Award
  - On Monday 11 January 2010 the first phone call over a cognitive radio network using CRAMNET

WARP lab

What have we done?
Consepts (2/2)

- Prediction Based Spectrum Management for Cognitive Radio Networks
- Distributed TDMA MAC Protocol Implementation with OLSR on Linux Enriched WARP for Ad hoc networks
    - In MobiCom 2009 Beijing, Best Demonstration Award
- A Demonstration of Frequency Hopping Ad Hoc and Sensor Network Synchronization Method on WARP Boards

WARP lab

What have we done?

Physical layer

- Energy and LAD based spectrum sensing algorithm
- WARP on HF
- M2M4 SINR estimator

MAC layer

- CSMA, distributed TDMA MAC for ad hoc networks, adaptive TDMA MAC, multi channel and hybrid protocols
- Distributed network synchronization algorithm
- Target systems centralized, ad hoc, and mesh networks

NET layer

- Multiple routing protocol support for WARP
- Messaging protocol for enabling remote access to the WARP network

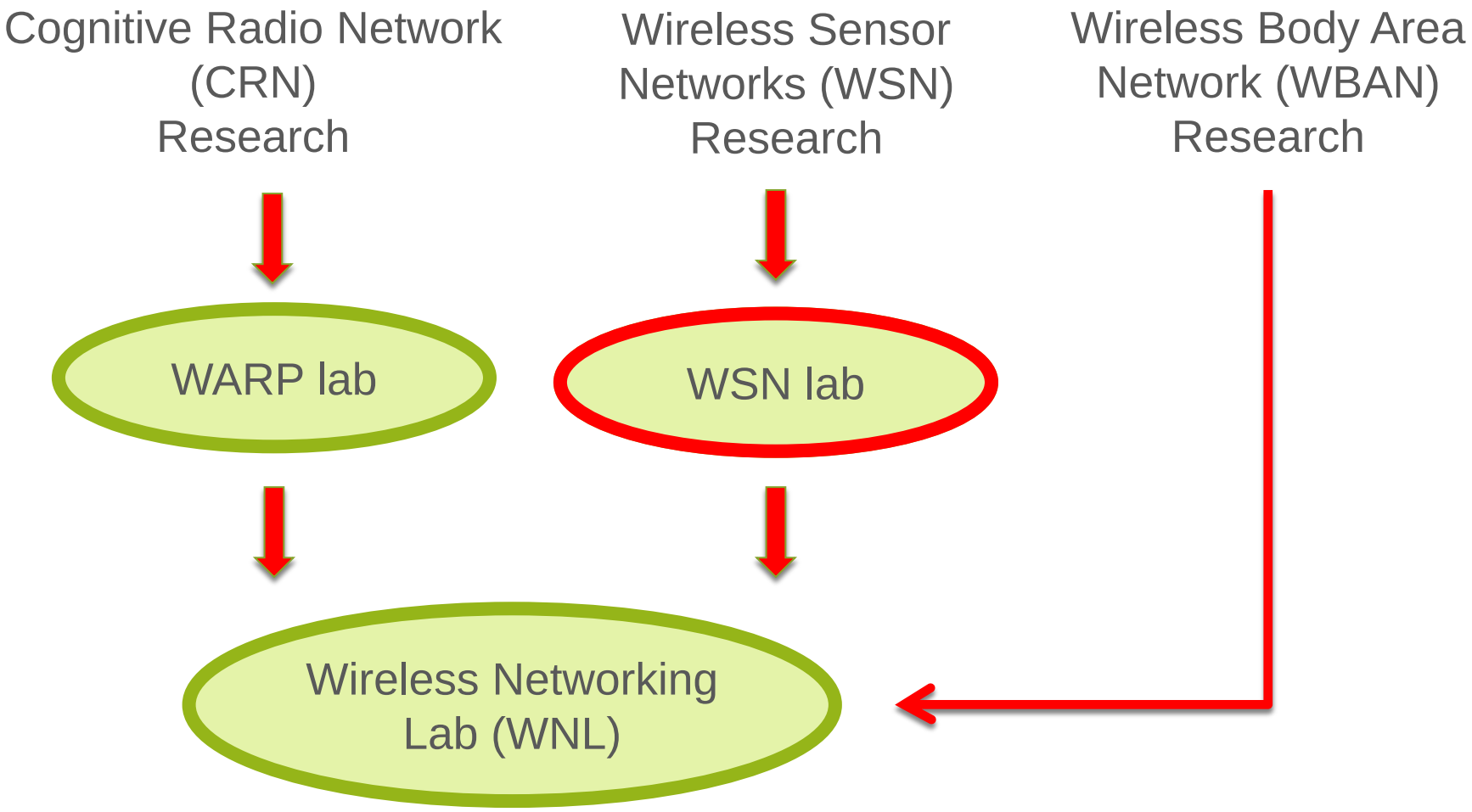
Platform development

- Porting of Linux to WARP (LE-WARP)

Cognitive Engine

- Centralized and distributed

WSN lab



WSN lab

What do we have?
Simulation tools

- Matlab, Simulink, OPNet

WSN lab

What do we have?
Sensor platforms

- ARM Cortex-M3 based
- 2 versions:
  - Sensor (single RF)
  - Router (2 RF and ethernet)
- Pluggable RF/Sensor modules
  - Continuously improved set of radio technologies

- Integrated sensors + several extension connectors
- Ethernet/SDIO capability
- Contiki SW platform

WSN lab

What have we done?

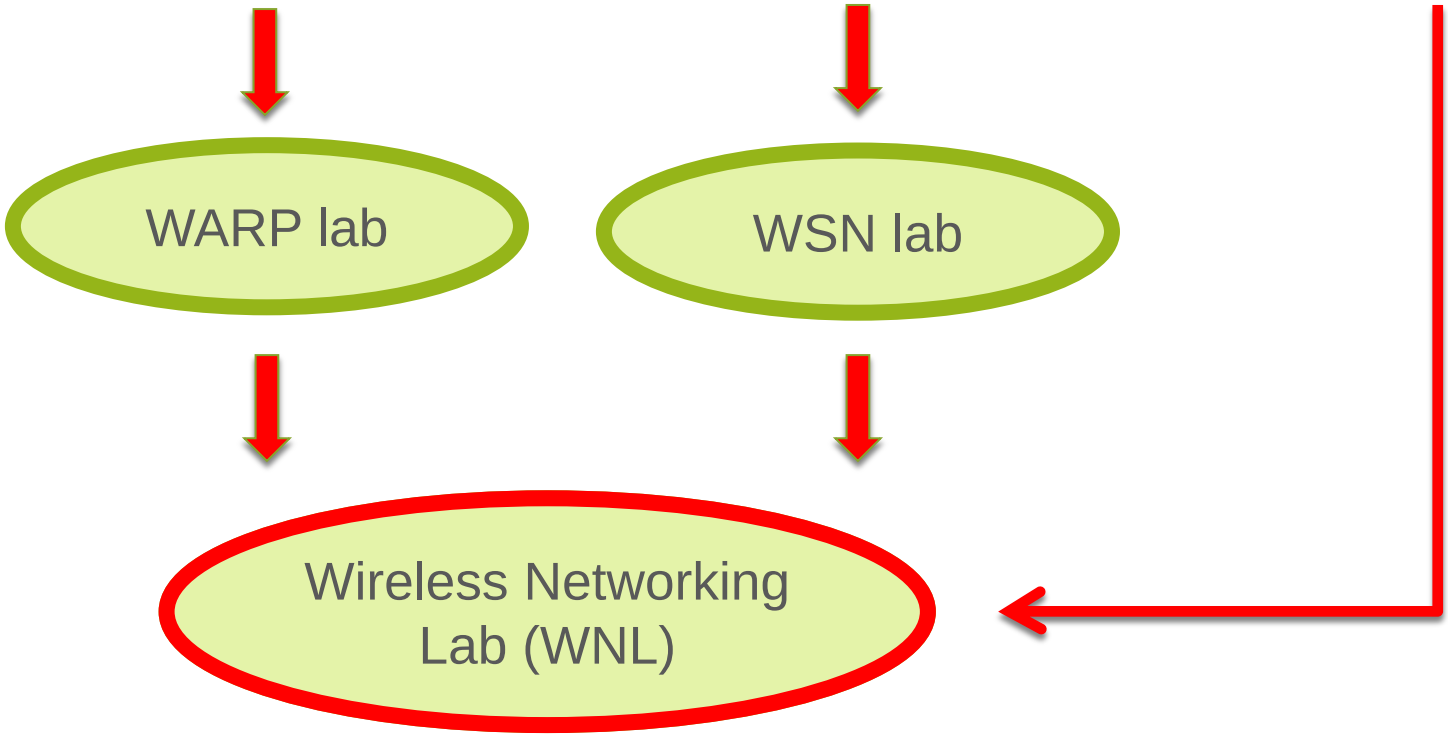
- First IP-based sensor network specification
  - nanoIP released in 2002
  - Also fully implemented on sensors and Linux
- Practical research on routing and power-saving issues using application demonstrator platforms
- RF positioning algorithms and measurements
  - Indoor positioning and position as a routing metric
- Hierarchical networking methods
  - Body-area networks and data collection systems
- Fall detection
- Information exchange using hand signs

Wireless Networking Lab

Cognitive Radio Network (CRN) Research

Wireless Sensor Networks (WSN) Research

Wireless Body Area Network (WBAN) Research



CWC Wireless Networking Lab

- Integration of WARP and WSN lab
- Also enables demonstration infrastructure for WBAN research
- Part of wireless infrastructure development at CWC

Why?

Sensors will penetrate the society in increasing numbers:

- Assisted living
- Smart homes
- Traffic (safety, regulation and billing),
- Security etc.

Wireless sensor networks will take several forms:

- Star topology
- Tree structure
- Mesh
- Direct sensor connection to the communications network.

Regardless of the topology, sensor data will eventually enter a communication network, wired or wireless.

Why?

Managing the increasing amount of produced data, together with the exploding complexity will present significant challenges. Therefore **versatile**, **flexible** and **integrated** research environments will be necessary for verifying the results of theoretical studies.

”From lab to field trials”

”From lab to field trials”
Example

Authorized Shared Access (ASA) concept

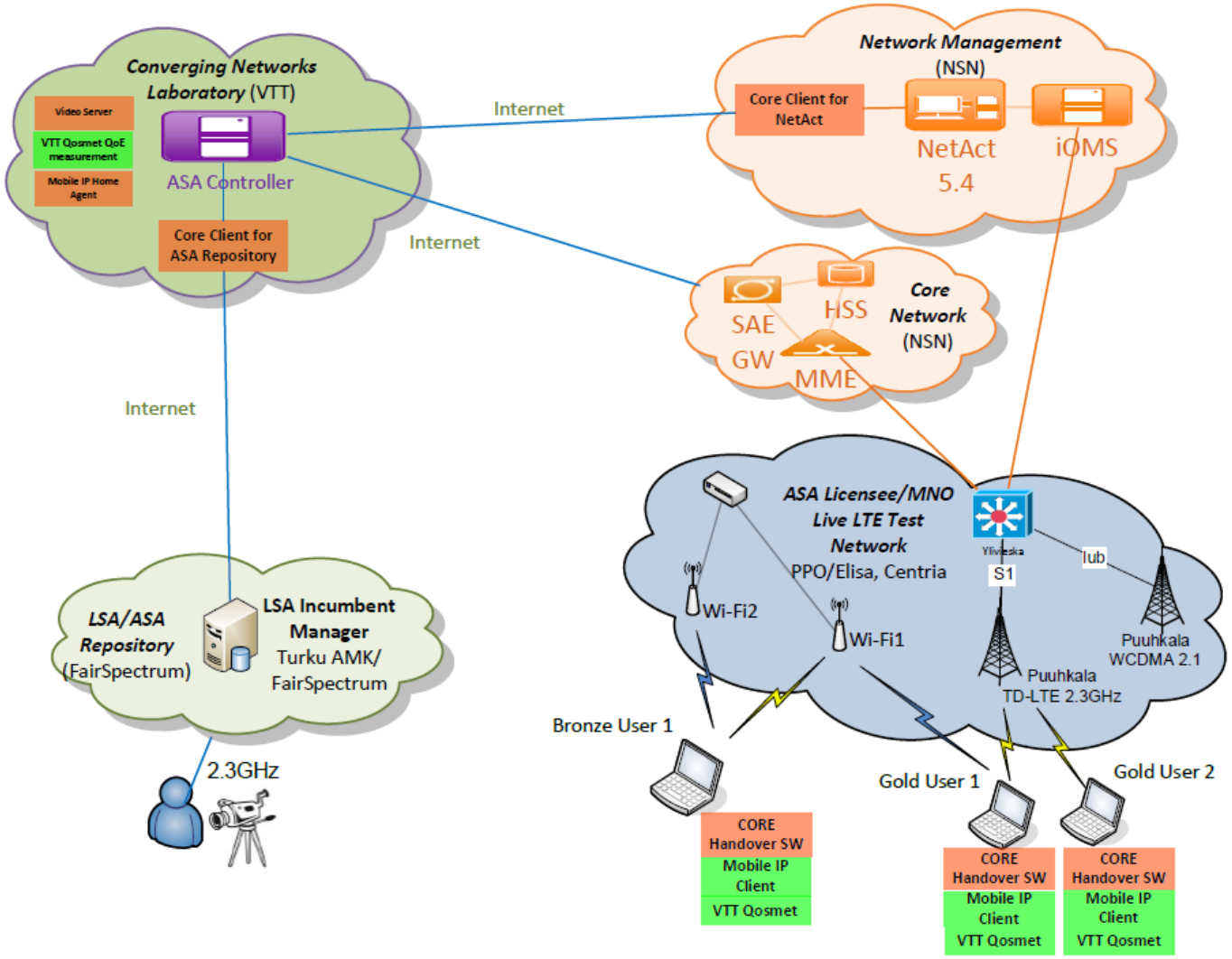
- Cognitive radio trial environment+ (CORE+) project*
- World’s First Demonstration of ASA with 4G/LTE

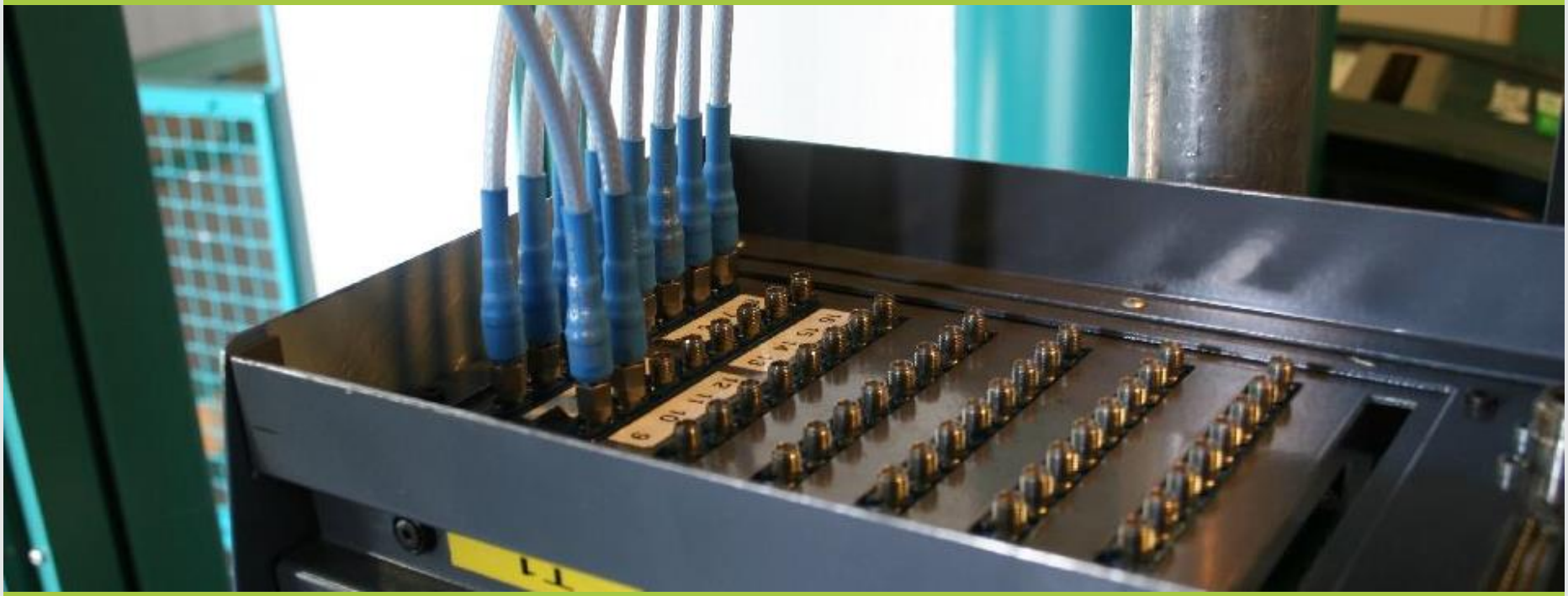
*) Three research organizations: VTT Technical Research Centre of Finland, Centria and University of Oulu

Seven industry companies: Nokia Siemens Networks, PPO, EXFO, Elektrobit, Renesas, Mobile Europe, PehuTec and Rugged Tooling

Two governmental organisations: the Finnish Defence Forces and Finnish Communications Regulatory Authority (FICORA)

Authorized Shared Access (ASA)





Thank You!