Lessons learned from hands-on development of multi-RAT virtual-RAN

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IS-Wireless is an advanced wireless communications company

Mission:
To become global provider of software-defined 4G and 5G mobile networks
Example customers
Dr. Sławomir Pietrzyk  
*Founder/CEO*

At IS-Wireless responsible for defining the long-term technical vision. Expert in wireless technologies and passionate entrepreneur. PhD in wireless from Delft University of Technology, pioneer work on OFDMA.
Intro: 5G Hype

Reality vs. expectations
Expectations

Higher system capacity: 1000 x capacity / km²

Energy savings and cost reductions

Reduced latency: < 1 ms

Higher data rate: 100 x typical data rate (even for high mobility)

Massive device connectivity: 100 x connected devices (even in crowded areas)

5G TARGETS

We are very far from the 5G targets

Meeting them requires a new approach to network deployment
Problem: typical Radio Access Network (RAN) deployment

- High cost
- High power (EMF exposure)
- Very long deployment time (12+ months)
- Low spectral efficiency [bit/s/Hz/m²] (capacity per m²)
- Significant coverage holes
- Poor indoor signal penetration
Problem: zoom-in

- Core centralized and separated from RAN

- RAN functionality locked to a particular chipset
- Scheduler per eNB/gNB causing fierce competition for resources

- Single eNB/gNB covering large area—low frequency reuse
- Low spectral efficiency [bit/s/Hz/m²]
- Interference between eNB/gNB
- High power eNB/gNB
Problem: typical cloud computing environment

- OTT service apps running on remote cloud
- Network functionality running on network hardware
- High cost
- High latencies
- Few suppliers for network functionalities
Problem: zoom-in

- Overuse of communication – traffic needs to travel long distance
- High energy consumption
- Monolithic non-portable network functionalities bound with hardware
- Another service (or operator) = another network
- Cloud resources run only OTT service applications
- Poor resilience to crashes

High latencies
Expensive infrastructure
Poor responsiveness

OTT service users
Cloud server
Solution: Open-RAN for multi-RAN

- Low cost
- Low power (negligible EMF exposure)
- Very short deployment time (days)
- High spectral efficiency [bit/s/Hz/m²] (capacity per m²)
- No coverage holes
- Easy indoor installation and great signal penetration
Solution: Edge Computing

- Efficient use of communications – traffic is anchored locally
- Low energy consumption
- Universal Edge servers able to run OTT service applications and Virtual Network Functionalities (VNF)
- Another service (or operator) = the same network
- High resilience to crashes

Move computing to the network edge

Reuse computing for both OTT and VNF
Products: 5G Mobile Networks based on Open RAN and Edge Computing

- RAN / Core / MANO running on off-the-shelf Edge server
- Hardware provider independent from functionality
- High level of portability

✓ Aggressive frequency reuse - very high spectra efficiency
✓ Interference solved by RAN controller
✓ High capacity, high number of users served
✓ Low power Radio Heads

Internet / OTT

Edge Server

Radio Heads
5G Mobile Networks based on Open RAN and Edge Computing

- Core framework able to connect 3rd party solutions
- MANO orchestrating underlying VNFs

- Executable on any GPU / Server
- Realizes slicing
- Lego-brick flexible functionality

- Commercial off-the-shelf computing device

- Efficient use of radio resources
- KPI optimization
- Support for various QoS /traffic

- 3GPP Standard compliant RATs (4G LTE, 5G NR, NB IoT)
- Support for WiFi

- Low power
- Rapidly deployable
- Hidden
- No permit

VNF Composition Framework

RAN controller

3GPP stack

Internet / OTT

Edge Server (developed by partners)

Radio Heads (developed by partners)
Solution: zoom into indoor

– Challenges
  • Multiple fronthaul candidates (fiber, mmWave, Ethernet, PLC)
  • Multiple RATs to be supported (LTE, 5G NR, WiFi)
  • Multiple tenants (slice users) to be supported

– Opportunities
  • Opening RAN interfaces
  • Unification of radio resource management
  • Efficient use of radio resources (RAT, t, f, space, MCS) across multiple RATs

– DevOps
  • Enable software-driven RAN instrumentation (feature-on / feature-off, feature composition)
  • Discovery of existing network elements and topology („RAN topology Manager“)
  • Effective retrieval of RAN measurements and configuration parameters (O1)
Organizational challenges

How do we tackle SD-RAN at IS-Wireless
Team: 50+ skilled telecom professionals

R&D Engineers
10 PhDs, SDN, NFV, RRM, Cloud, MANO, Edge, Slicing, PHY, OFDM(A), MIMO

Protocol Engineers
UMTS, LTE, 5G NR, WiFi, IoT, PLC

Software Developers
C, C++, Java, Python, RTS, QT

Team Leaders
Lean design, TQM, Agile, Kanban, Customer Development

Office
300m² in Piaseczno HQ
Small office in Łódź
Small office in Warsaw (Warsaw University of Technology)
Why now: technology curves and IS-Wireless activities over the past

- IS-Wireless is present on the 4G market since 2006 what gives competitive advantage in the form of: team, know-how, customers, partners
- IS-Wireless is present in R&D on 5G since 2012 what gives sound understanding and confidence in systems' evolution
Strategy: universal software platform for numerous markets

By customizing our solution we can address other vertical markets

We start by addressing enhanced mobile broadband

Massive MTC (IoT)  
Low latency  
Ultra-reliability
DevOps view

Doing it well
Challenges / requirements

– Vast amount of 3GPP specs to capture (4G, 5G);
– Specs do not explain everything
– Real-time / non-real time protocols need to coexist
– Functions need to be executed on either virtual or physical machines
– Need to control the process effectively (and be able to track back functions to requirements)
– Start with testing as early as possible (agile)
Workflow - automation

3GPP Specs

3GPP TS 23.501 V15.2.0 (2018-06)

Technical Specification Group Services and System Aspects; System Architecture for the 5G System; Stage 2 (Release 15)

UML model

C code
Development flow

git
version control

autotools
project control

framework code

UML-RT
real-time model

C
generated

C
Hand filled

gcc
clang
icc
(cross)
compiling

3rd-party libraries

ØMQ
ASN1.C

GCC

Intel

Development flow
Deployment flow

SD-RAN

MANO

Open Source MANO

ONAP

OPEN NETWORK AUTOMATION PLATFORM

Element Manager

VNF

VNF

PNF

PNF
Open RAN

Breaking down the silo mentality
Open RAN (O-RAN)

- Founded as xRAN in 2016 by AT&T, Deutsche Telekom, SK Telecom and Stanford University
  - 2018 xRAN joined C-RAN Alliance + extending the scope to form Open RAN Alliance
- Scope:
  - promote a software-based, extensible, open Radio Access Network (xRAN)
  - standardizing critical elements of the xRAN architecture (interfaces).
- Aims to
  - bring cloud scale economics to the RAN
  - bring agility to the RAN
- Themes:
  - Openness (new interfaces vs 3GPP, IMS-like approach*)
  - Intelligence (AI/ML, policies, 3rd party apps)
- Focus
  - on specifications and PoC
O-RAN Alliance Ref Architecture
Related EU projects of IS-Wireless

5G Essence (due: Nov2019)
EuWireless (due: Mar2020)
ORCA (finishes now)
TeamUp5G (due: 2021)
Morphemic (due: 2022)
Summary
Summary

Of lessons learnt from hands-on development of multi-RAT virtual-RAN

How
How it needs to be build?
Work split, tools, methodologies

What
What needs to be build?
Specs, features, differentiators

Who
Who should build it?
Team, information sharing, recruitment
"A good hockey player plays where the puck is. A great hockey player plays where the puck is going to be." Wayne Gretzky

„należy jechać tam, gdzie krążek zmierza, a nie tam, gdzie znajduje się w danym momencie“
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