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Software defined radio as a vehicle for commercialisation of university research: Lessons learned in 5G and opportunities for 6G

Prof Rob Maunder
Professor at University of Southampton
Founder and CTO at AccelerComm

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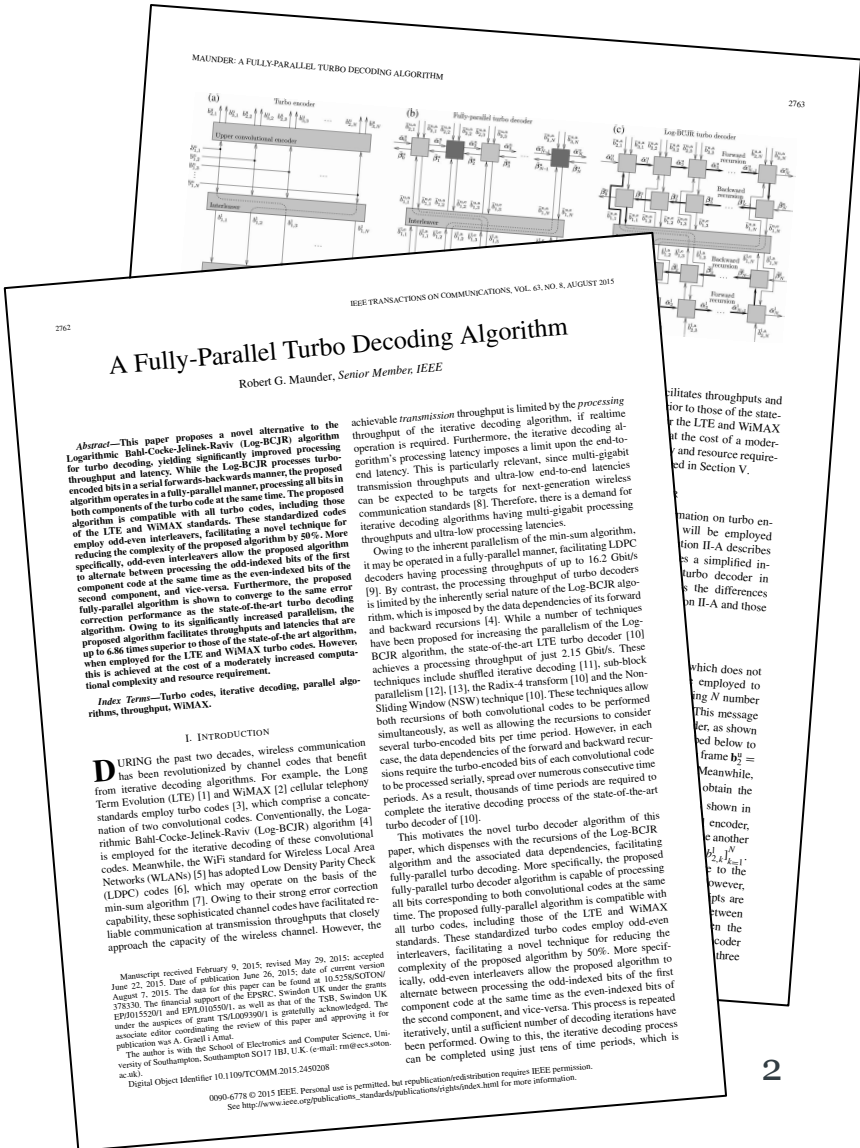
Overview

- Pathway to spin-out
- Contributing to 3GPP
- O-RAN standards
- Lessons learned in 5G
- Opportunities for 6G



MAUNDER: A FULLY-PARALLEL TURBO DECODING ALGORITHM

2763

IEEE TRANSACTIONS ON COMMUNICATIONS, VOL. 63, NO. 8, AUGUST 2015

2762

A Fully-Parallel Turbo Decoding Algorithm

Robert G. Maunder, *Senior Member, IEEE*

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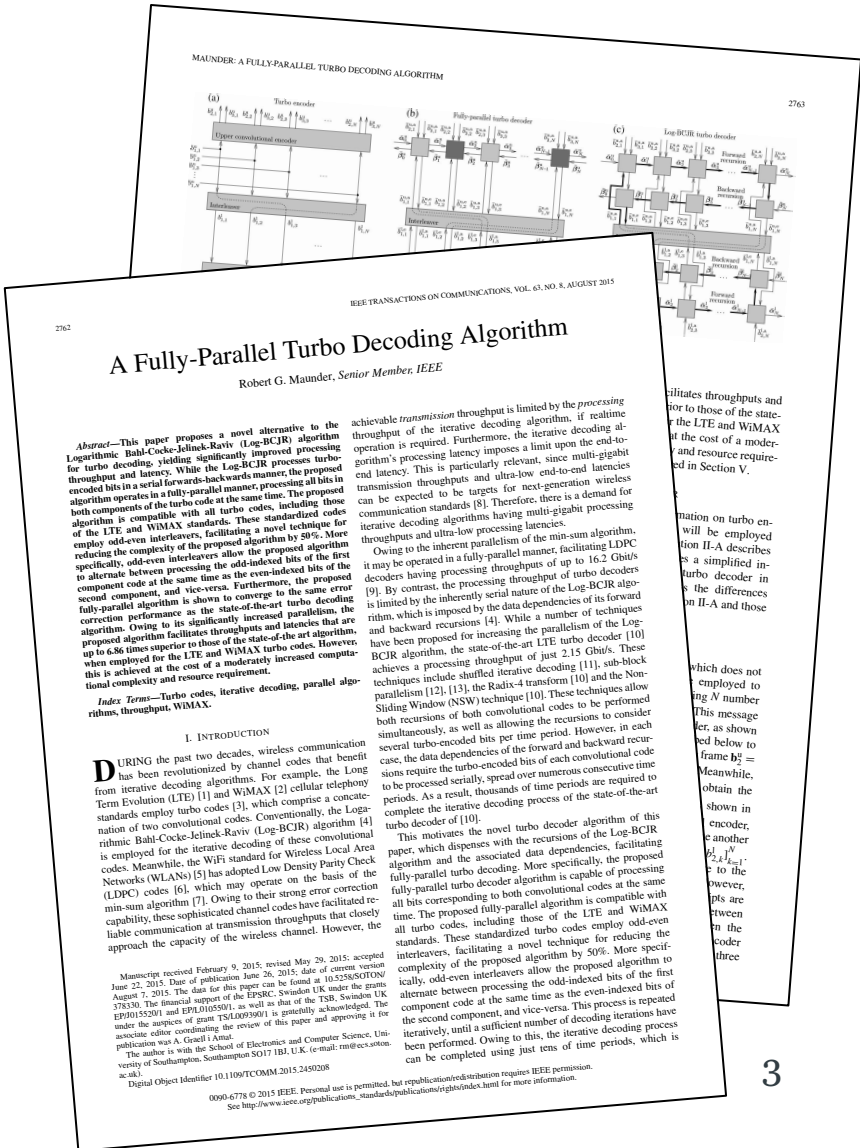
Our research

- 5G mobile broadband targets ultra-high throughputs
- But reliable communication requires complex processing
- Hardware-accelerated processing is required to keep up
- We jointly design the processing algorithm and hardware
- Our designs are aimed at user equipment and basestations



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EPSRC project

- Case for support – proof of concept simulation results
- Pathways to impact – “we will generate a patent from each aspect of the project”
- Reviewer – “why haven’t you patented the proof of concept?”
- Response – “thanks for the encouragement!”

EPSRC
Engineering and Physical Sciences Research Council

Patent

- Invention disclosure form on fully-parallel turbo decoder
- Faculty patent panel meeting – “we will fund the UK patent application, but you must find a licensee so that the patent pays for itself”
- Waited for industry to come knocking on our door…
- One year later – should we make global applications?
- Patent panel meeting – “okay, but you must step up your efforts to find a licensee: go to California”

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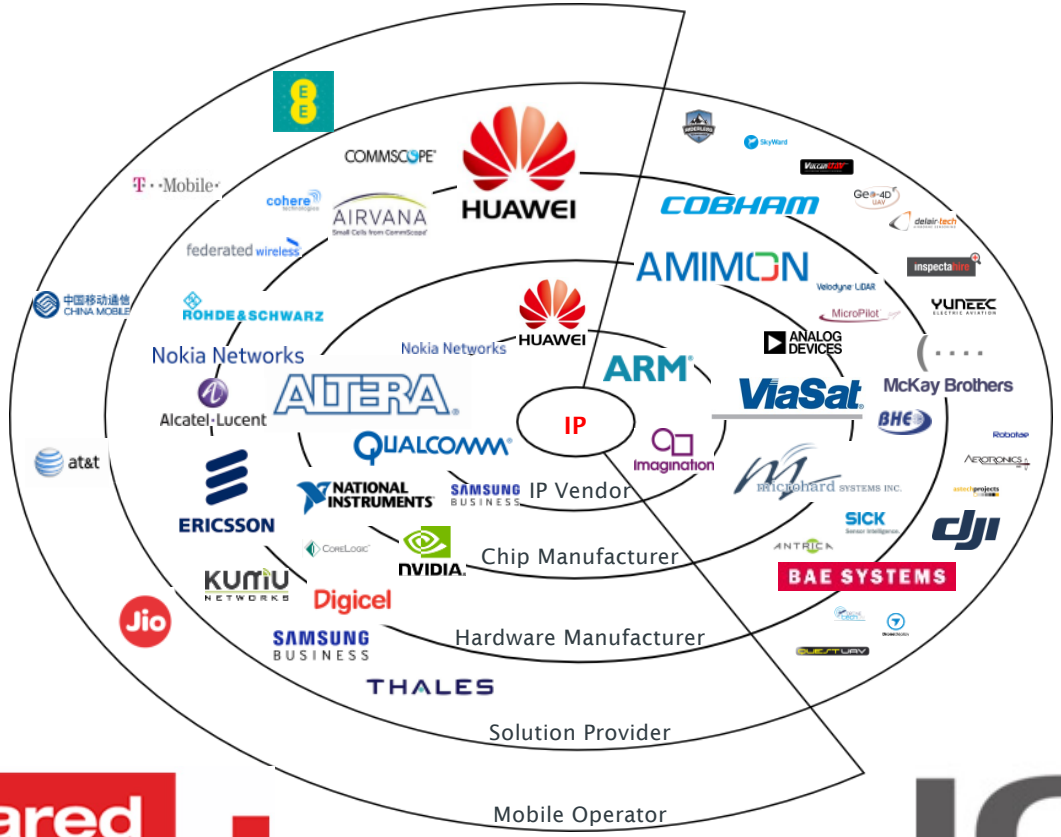
SETsquared Innovation to Commercialisation of University Research

Taihai Chen

Cellular Market



Specialist Market

Supply Chain

SETsquared PARTNERSHIP
Universities of Bath, Bristol, Exeter, Southampton & Surrey

ICURe

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Innovate UK Aid for Start-ups grant

- ICURe panel recommended applying for Innovate UK funding
- Wrote a business plan, including market research, competitor analysis, business model, financial forecasts, funding requirements, milestones, IP arrangements, risk analysis.
- Awarded £500k to be spent over 2 years


AccelerComm

Accelerating the next generation of wireless communications

Business Plan

CONFIDENTIAL

Competition	Identifying and Commercialising University Research (ICURe) Pilot Programme
Organisation Name	AccelerComm
Organisation Contact Details	Taihai Chen AccelerComm Room 4008, Building 53 University of Southampton University Road Southampton, Hants. SO17 1BJ, U.K. Tel: 07503688876 E-Mail: t.chen@southampton.ac.uk

Disclaimer: The information in this report should be treated as commercial-in-confidence and used purely for the purpose of accessing AccelerComm for InnovateUK Aid for Start-Ups funding

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3GPP 5G New Radio standardisation

- AccelerComm incorporation happened in March 2016, on the basis of fully parallel turbo decoder patent
- Standardisation of channel coding for 3GPP 5G New Radio began in May 2016
- AccelerComm attended 3GPP meetings to support adoption of turbo codes in 5G NR, but ultimately LDPC and polar codes were selected instead
- AccelerComm had to pivot to developing LDPC and polar solutions, but in hindsight this was a bigger opportunity than turbo codes would have been

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Benefits and challenges of contributing to 3GPP

- 3GPP is a very competitive environment – everybody wants to get their patents into the standard – "standards essential patent"
- Very difficult to achieve for anybody apart from big companies, who can form allegiances and control decisions
- But only a minority of contributors had implementation experience and AccelerComm was able to make valuable contributions here
- Gained valuable insights into motivation for standardisation decisions and the advanced techniques that they enable
- Able to generate "implementation essential patents"
- Also able to get AccelerComm onto the radar of important industry players

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3GPP RAN1 #86bis

R1-1610604 **WF on channel codes for NR eMBB data** **AccelerComm, Ericsson, Orange, IMT, LG, NEC, Sony**
Revision of R1-1610545
Proposal:

- Adopt LDPC code and turbo code, to mitigate the concerns associated with the implementation of flexible LDPC

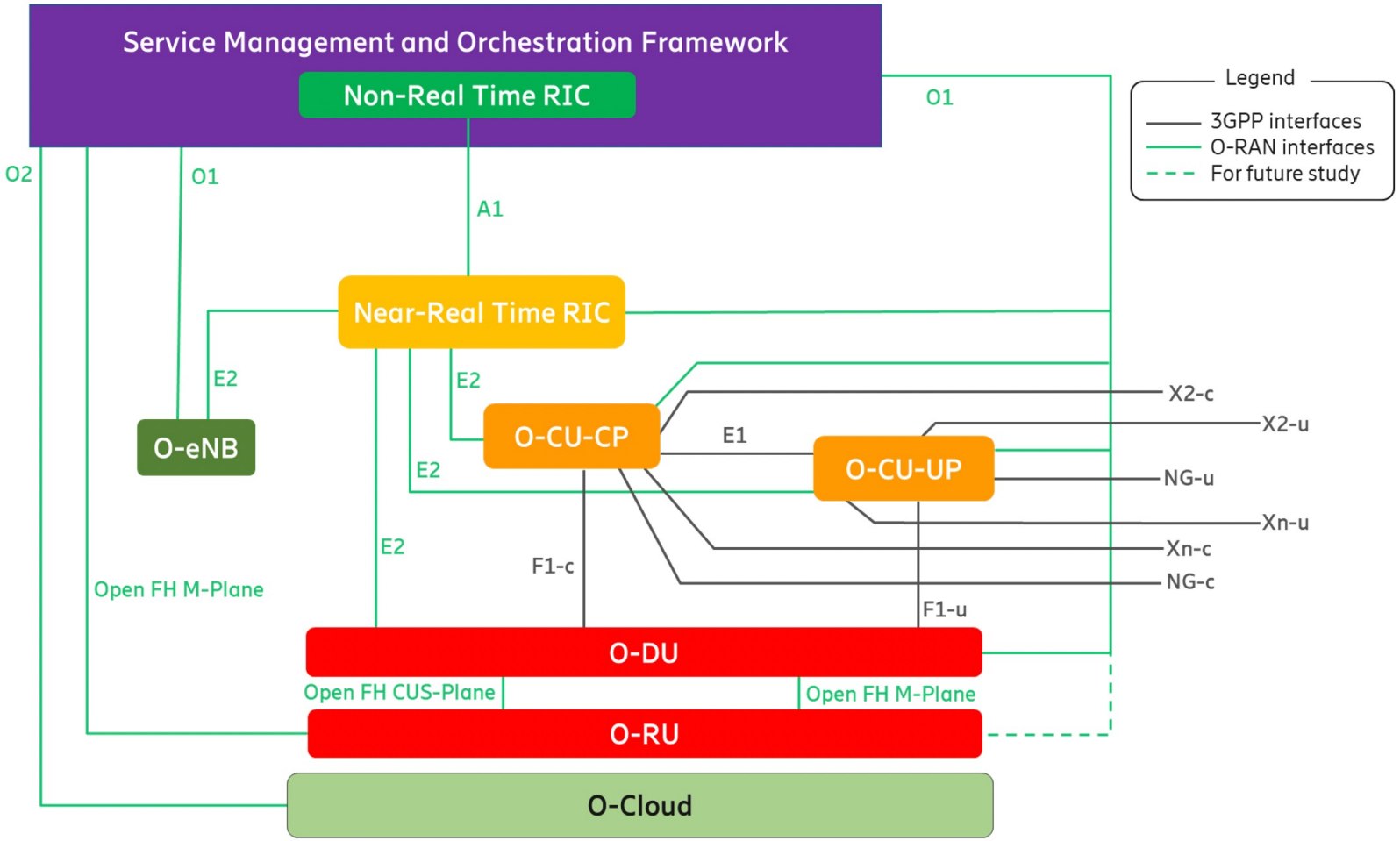
R1-1610767 **Way forward on eMBB data channel coding** **Samsung, Qualcomm Incorporated, Nokia, Alcatel-Lucent Shanghai Bell, Verizon Wireless, KT Corporation, KDDI, ETRI, IITH, IITM, CEWiT, Reliance Jio, Tejas Network, Xilinx, Sony, SK Telecom, Intel Corporation, Sharp, MTI, National Instrument, Motorola Mobility, Lenovo, Cohere Technologies, Acorn Technologies, CableLabs, WILUS Inc, NextNav, ASUSTEK, ITL**
Revision of R1-1610689
Also acceptable to Ericsson
Proposal:

- Adopt LDPC code for eMBB data channel as single coding scheme

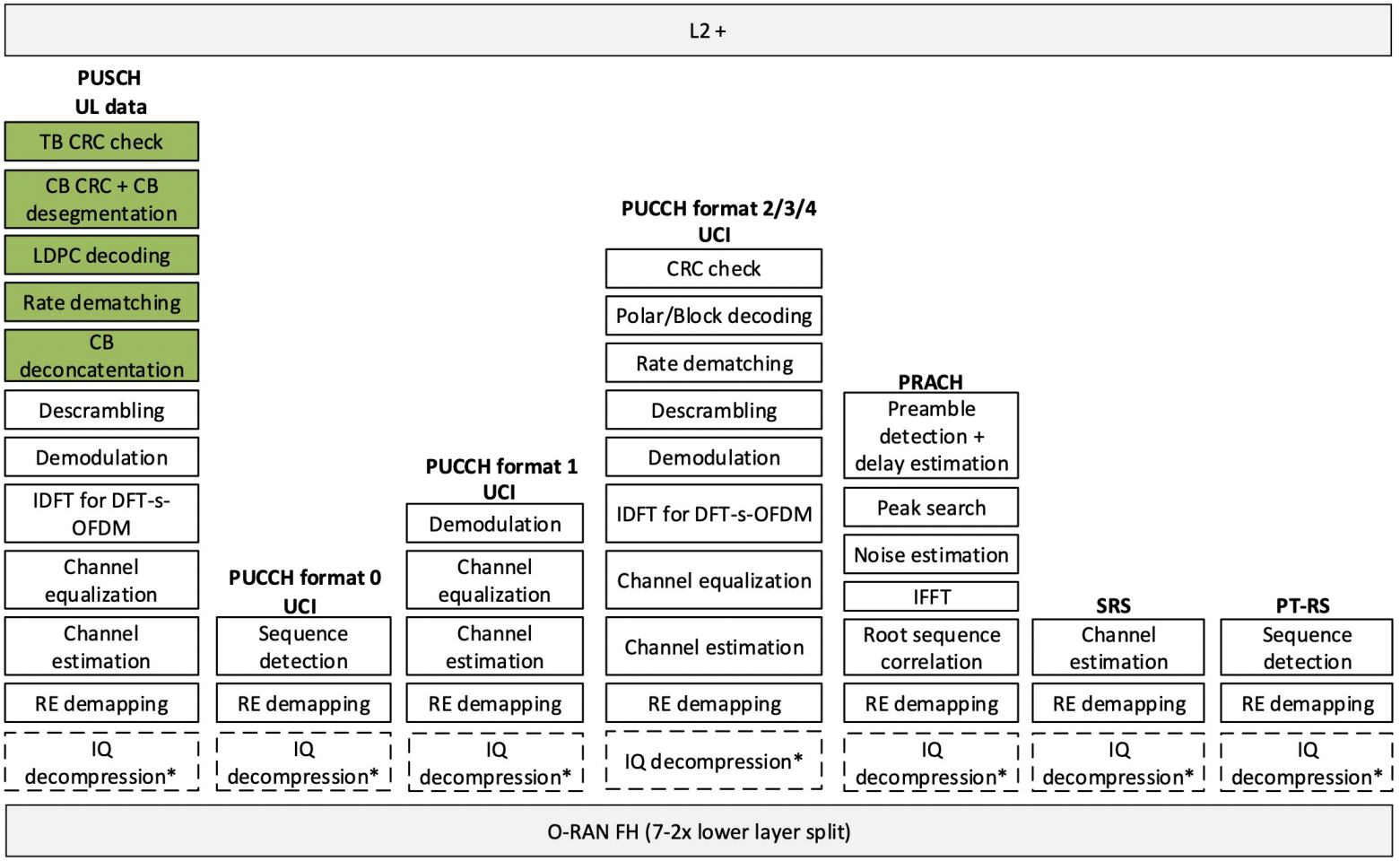
R1-1610850 **WF on channel codes** **Huawei, HiSilicon, Acer, Bell, CATR, China Unicom, China Telecom, CHTTL, Coolpad, Deutsche Telekom, Etisalat, InterDigital, III, ITRI, MediaTek, Nubia Technology, Nuel, OPPO, Potevio, Spreadtrum, TD Tech, Telus, Vivo, Xiaomi, Xinwei, ZTE, ZTE Microelectronics**
Revision of R1-1610668
Also acceptable to CATT
Proposal:

- Polar code is supported as a channel coding scheme for NR eMBB data channel

O-RAN – basestation building blocks



O-RAN – hardware-software split



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5G NR PHY software stacks

- Intel FlexRAN – 5G NR PHY layer, optimised for Intel x86 CPUs, can use FPGA to accelerate LDPC coding and fronthaul connectivity, integrated into base station equipment by several vendors and deployed by numerous operators, source code available with license from Intel, or binary available in O-RAN reference implementation
- Open Air Interface – open source implementation of 5G NR Core, CU, DU, RU and UE, some optimisation for Intel and AMD x86 CPUs, some support for ARM CPUs, support coming for FPGA acceleration of LDPC coding
- Matlab 5G toolbox – source code for 5G NR modeling, simulation, and verification

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Lessons learned in 5G

- O-RAN is decomposing a basestation into building blocks and standardising interfaces between them – a vendor can focus on building an individual building block, at various levels of abstraction
- This has significantly reduced the barrier to entry, but it is still necessary to develop multi-disciplinary teams for signal processing, hardware, software, interfacing, …
- Also, still important to build expertise at the system level above that of your solution, so that you can understand your customer's requirements
- Eco-system is vital – roadmaps must be aligned between IP provider, hardware vendor, software vendor, system integrator, operator, standards organisations

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Opportunities for 6G

- New ideas must be championed by big established players in order to get into 3GPP standards - an example of this is the invention of polar codes in 2008 and their 3GPP standardization in 2016 thanks to Huawei's support
- Ideas can be pushed into big established players by developing demos based on software defined radio and developing relationships with vendors and operators
- A good example of this is Orthogonal Time Frequency Space modulation, which Cohere Technologies is now trailing with Vodafone, Deutsche Telekom, Intel FlexRAN and Mavenir
- It is important to think about how the idea fits into the building blocks of O-RAN – Cohere Technologies are deploying their technology in the radio intelligent controller, which controls the CU, DU and RU.


Thank you
Find out more at:
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https://futureworlds.com/?s=accelercomm