CW: The 7th Future of Wireless International Conference
Reinventing the network infrastructure industry

Moving 5G Forward From Vision to Reality

Alan Carlton, InterDigital Europe
23rd June, 2015
What I will be Talking about Today

- A Little Background on InterDigital
- Summary of InterDigital 5G Vision
- Review of a few of our 5G Projects
Four decades of leading technology discovery and innovation

Widely known for wireless standards but today we are really quite diverse

Diverse R&D activities in radio, backhaul, video, with main focus on 5G and IoE

Recently spun out two new startup companies: WOT.io and Xcellair
• Central mission is to drive technology collaboration & partnership initiatives across the European stage
• Happy to call London and “Tech City” our home affording us easy access to anywhere in Europe
• We play in Horizon 2020, 5GPPP, Innovate UK and are always looking to create new projects and alliances
• Already seeing some good results with **Four Wins** in EU competition (e.g. H2020) so far
• Also driving a integrated transport initiative, “oneTRANSPORT” in the area of the IoT
So where is our wireless industry today?

We have come a long way but have really only just begun...
CONNECTIVITY View - And in the Beginning there was 9.6kbps!

Really quite amazing when you stop and think about it...

<table>
<thead>
<tr>
<th>2G Narrowband Era</th>
<th>IMT-2000</th>
<th>3G Broadband Era (for the few)</th>
<th>IMT-A</th>
<th>4G ...and for the masses</th>
</tr>
</thead>
</table>

- **IMT-2000**
  - WCDMA
  - HSPA
  - HSPA+

- **IMT-A**
  - LTE
  - LTE-A

- **2012+**
  - 100,000X on GSM Phase 1

### 1990+

- **GSM-EDGE**
  - 9.6kbps
  - GSM Phase 1

### 2G Narrowband Era

- **Peak Data Rate:**
  - UL=118Kbps
  - DL=236Kbps

- **Spectral Efficiency:**
  - 0.17-0.33 (Bit/s/Hz)

- **Carrier Bandwidth:**
  - 200kHz

- **Latency (RTT):**
  - 300ms

### 3G Broadband Era (for the few)

- **WCDMA**
  - 384Kbps
  - 2Mbps

- **HSPA**
  - 5.7Mbps
  - 14Mbps

- **HSPA+**
  - 11.5Mbps
  - 42Mbps

### 4G ...and for the masses

- **LTE**
  - 50Mbps
  - 150Mbps

- **LTE-A**
  - 500Mbps
  - 1Gbps

- **2012+**
  - 100,000X on GSM Phase 1

### Peak Data Rate:

- **LTE Category 4**

### Spectral Efficiency:

- **Carrier Bandwidth:**
  - 200kHz

- **Latency (RTT):**
  - 300ms

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SERVICES View: And in 5G it will be all about EVERYTHING!
-In 5G the Everything is Information and Information will be Everything-

Wave 1 (About one THING)  Wave 2 (A Few more THINGS)

- Glory days of GSM
- IMS promises
- Integrated telephony applications

- Walled garden worries!
- Ride of the OTT
- Rise of the mobile internet

5G: The Internet of EVERYTHING

- A new status quo
- The video experience

Seamless Integration of Verticals (Healthcare, Energy, Transport, etc.)

The living experience

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Boiler Plate Alert! Defining Requirements For Everything is Tough

<table>
<thead>
<tr>
<th></th>
<th>LTE</th>
<th>LTE-A</th>
<th>5G video ++</th>
<th>IoE</th>
<th>TACTILE internet</th>
<th>mission critical</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Peak Data Rate</strong></td>
<td></td>
<td></td>
<td>10-50Gbps</td>
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<tr>
<td>5G</td>
<td>50Mbps</td>
<td>500Mbps</td>
<td>1Gbps</td>
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<td>4G</td>
<td>150Mbps</td>
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<tr>
<td><strong>Spectral Efficiency</strong></td>
<td>16.32</td>
<td>30</td>
<td></td>
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</tr>
<tr>
<td><strong>Carrier Bandwidth</strong></td>
<td>upto20MHz</td>
<td>upto100MHz</td>
<td></td>
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<tr>
<td><strong>Latency (RTT)</strong></td>
<td>~10ms</td>
<td>~5ms</td>
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*Key requirements harmonized & agreed in ITU-R WP5D

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So what can we confidently say about 5G as of today

- 5G will certainly be the most diverse generation in history with perhaps the most challenging set of requirements of any “G”
- on the **5G air interface**: There will be “at least” two new radios 1.) <6GHz developed as an evolution & 2.) >32GHz more revolution (?)
- on the **5G network**: It will be built on the base of programmability and SDN/NFV will provide the cornerstones for it’s essential fabric
- on the **5G system**: It will be as much about the *fog* as it will be about the *cloud* and where the line falls between will define 5G
- on the **5G bottomline**: Not to be lost 5G and perhaps above all else 5G will be about **FLEXIBILITY** and **SIMPLIFICATION**
5G Projects Review
Making Vision Reality One Innovation at a Time...

(or new possibilities with SDN/NFV)
What is Information Centric Networking (ICN)?

• We think it is simply an inevitable destination
• A paradigm shift away from client-host comms
• Focus is on content & name based addressing
• Brings pub-sub model to core networking

Benefits and Challenges of ICN

• Better utilization through native multicast!
• Better privacy and path resilience to failures
• But changing the internet is really difficult!
• But that was before SDN/NFV came along

POINT is a EUH2020 Research & Innovation Programme Funded Project under grant No. 643990

8 Partners inc. Primetel, Intracom, Ell-I, CTVC, Aalto
POINT: A Practical SDN Approach to the Enablement of ICN

Unicast explosion simply not an option in 5G
- Single client-single host communication is well recognized as an inefficient approach
- Subject of many workarounds through the years, mostly “caching & redirection”
- POINT implicitly supports native multicast

Todays Legacy IP Networking Approach is Unsustainable!

http://www.point-h2020.eu/
POINT: A Practical SDN Approach to the Enablement of ICN

POINT ICN Solution will Drive Down Bandwidth Costs

Benefit #1: True Multicast

POINT: The Innovative ICN technology approach for competitive 5G (or before) operator networks

• Aligns introduction of ICN concepts with SDN/NFV proliferation and growing trend to programmable infrastructure models
• Combines seamlessly and complements emerging fog/edge computing thinking

ICN Gateway Layer

ICN Intelligence
SDN controller

Single Operator: POINT ICN Approach

App (e.g. HTTP)

IP

IP

ICN

L1/L2

CPE

ICN Gateway Layer

Implicit Multicast

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http://www.point-h2020.eu/
POINT: A Practical SDN Approach to the Enablement of ICN

Cache Mgmt.
ICN Intelligence
SDN controller

Surrogate

App (e.g. HTTP)

ICN Gateway Layer

Single Operator: POINT ICN Approach

implicit Multicast

ICN Gateway Layer

CPE

SDN controller

Surrogate

Benefit #2: Deep Caching

POINT Solution will Drive Down Bandwidth Costs

POINT: The next logical step up for deep content caching in dynamic surrogates

- Surrogates are softwarized servers that bring content closer to mobile end users AND create new Caching as Service possibilities for Operators
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Surrogate instances are controlled by SDN/ICN core functions which utilize ICN knowledge about what information is requested where by how many users

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http://www.point-h2020.eu/
XHAUL: A SIMPLIFYING Twist on Backhaul and Fronthaul

Backhaul and Fronthaul Systems have evolved on quite different trajectories
• A wide array of L1-L3 technologies are deployed in today's FH and BH systems
• Carrier Ethernet preferred on Backhaul
• CPRI approach common in Fronthaul
• Independent management systems

XHAUL aim is unification of Backhaul and Fronthaul in common SDN fabric
• Unprecedented 5G “Everything” needs will demand a new level of dynamism
• Demo in Berlin planned + standards

XHAUL is a EUH2020 (5GPPP) Research & Innovation Programme Funded Project under grant No. 671598

21 Partners inc. Orange, TIM, Telefonica, NEC, Nokia, Ericsson
XHAUL: An Ambitious SDN Approach for BH & FH Unification

XHAUL Node (e.g. a 5G Base Station)

Key Challenges Being Addressed in XHAUL
- Explore novel SDN-based control architectures to support flexible functional splits for dynamic KPI optimization
- Develop common abstractions on southbound i/f (including unified framing) across disparate tech to enable a seamless SDN integration.
- Deliver a suite of enabling applications for fluid management of unified and virtualized XHAUL resources
- Special focus on flexible sharing/multi-tenancy support

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We will be bringing our EDGEHAUL™ solution to Berlin Trial

• Low-cost, high capacity, scalable design for today’s small cell backhaul and future 5G architectures
  • Leverage high volume WiGig baseband
  • 60GHz Phased Array with electronic beam steering reduces installation cost and provides interference management

• Gbps throughput over 200-300m range suitable for dense urban small cell deployments

• Mesh connectivity enables an adaptable network around interference and congestion

• High capacity, low-latency inter-cell connectivity ideal for 5G advanced RAN architectures
  • RAN Virtualization
  • Edge Intelligence
5G Socio-Economic Study: Refining the Challenge of EVERYTHING - An EU Commission Funded & Supported Study -

• Develop a better understanding of the potential economic impact of 5G networks in vertical markets

• Identify the relative potential of each use for social and economic benefits in the European context

• Fully informed by and consistent with the 5GPPP initiatives while offering fresh and independent perspective

• Open Stakeholder hearings on 22 Sep and workshop on 19 October – Please Join in!

• Follow on Linkedin: http://linkd.in/1Kra7n4
Thank you!

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