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

Moving 5G Forward From Vision to Reality

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23rd June, 2015

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What I will be Talking about Today

- A Little Background on InterDigital

- Summary of InterDigital 5G Vision
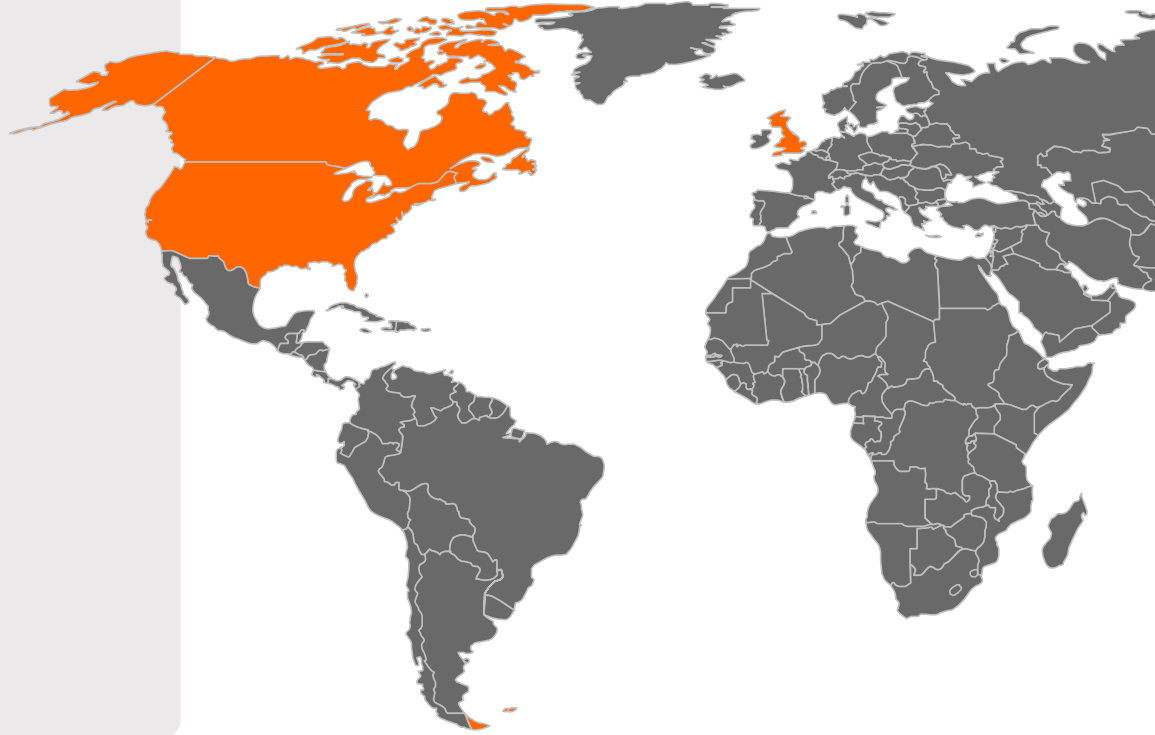
- Review of a few of our 5G Projects

InterDigital Snapshot: Invention, Collaboration, Innovation

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

InterDigital Europe, Ltd. – Open for Business July 2013

- 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!
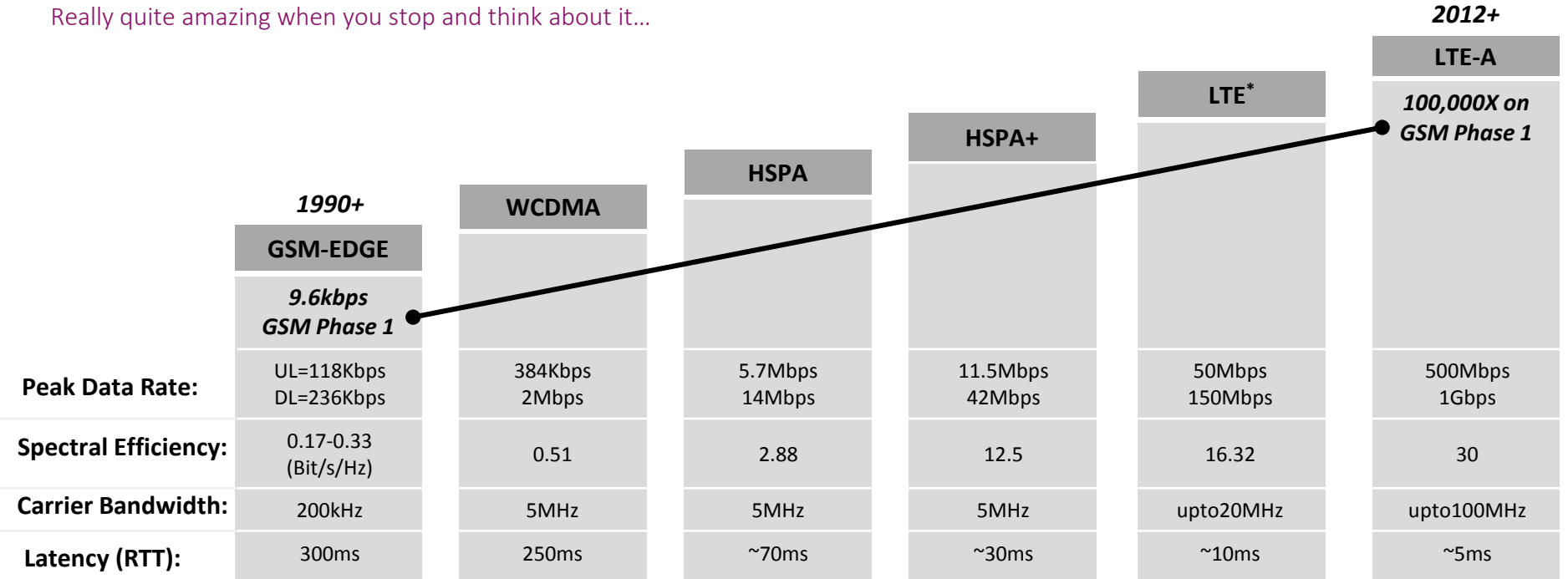
2G Narrowband Era ● IMT-2000 **3G** Broadband Era (for the few) ● IMT-A **4G** ...and for the masses

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

2012+

1990+

	GSM-EDGE *9.6kbps GSM Phase 1*	WCDMA	HSPA	HSPA+	LTE*	LTE-A *100,000X on GSM Phase 1*
Peak Data Rate:	UL=118Kbps DL=236Kbps	384Kbps 2Mbps	5.7Mbps 14Mbps	11.5Mbps 42Mbps	50Mbps 150Mbps	500Mbps 1Gbps
Spectral Efficiency:	0.17-0.33 (Bit/s/Hz)	0.51	2.88	12.5	16.32	30
Carrier Bandwidth:	200kHz	5MHz	5MHz	5MHz	upto20MHz	upto100MHz
Latency (RTT):	300ms	250ms	~70ms	~30ms	~10ms	~5ms

*LTE Category 4

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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-

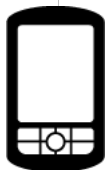Wave 1 (About one THING) → Wave 2 (A Few more THINGS) → 5G: ~~The Internet of~~ EVERYTHING

Glory days of GSM

IMS promises

Walled garden worries!

Ride of the OTT

A new status quo

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

The living experience

The video experience

Integrated telephony applications

Rise of the mobile internet

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Boiler Plate Alert! Defining Requirements For Everything is Tough

4G purposed mainly for VIDEO... **IMT-2020** → **5G** video ++ ● IoE ● TACTILE internet ● mission critical

	LTE	LTE-A	<1millisecond latency (when needed!)	10-50Gbps peak data rates (when needed!)	90% Energy reduction per service
Peak Data Rate:	50Mbps 150Mbps	500Mbps 1Gbps	100-500MHz Carrier Bandwidth	Higher Density: Millions of connections per km^2	Higher Traffic Volume: 1-10 Tbps per km^2
Spectral Efficiency:	16.32	30	Rapid Service Creation (from days to minutes)	Sustainable Total Cost of Owner for all players	User Definable Security & Privacy
Carrier Bandwidth:	upto20MHz	upto100MHz			
Latency (RTT):	~10ms	~5ms			

*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**

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5G Projects Review
Making Vision Reality One Innovation at a Time…

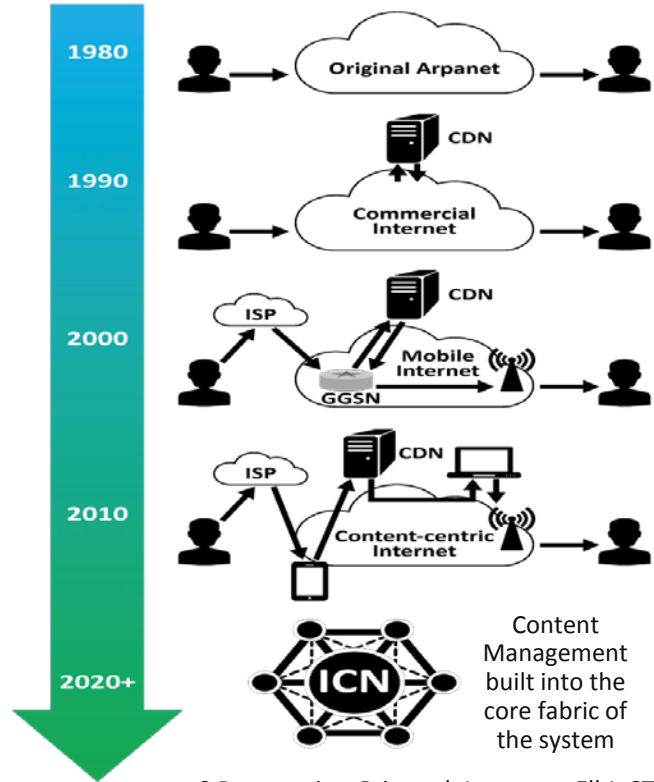*(or new possibilities with SDN/NFV)*

POINT: A FLEXIBLE Twist on Information Centric Networking
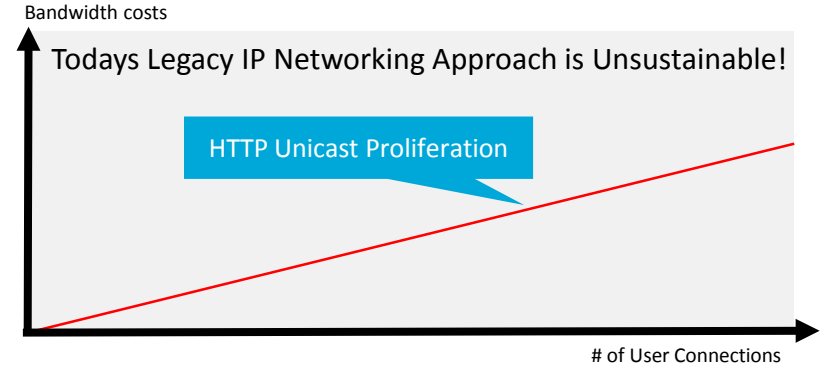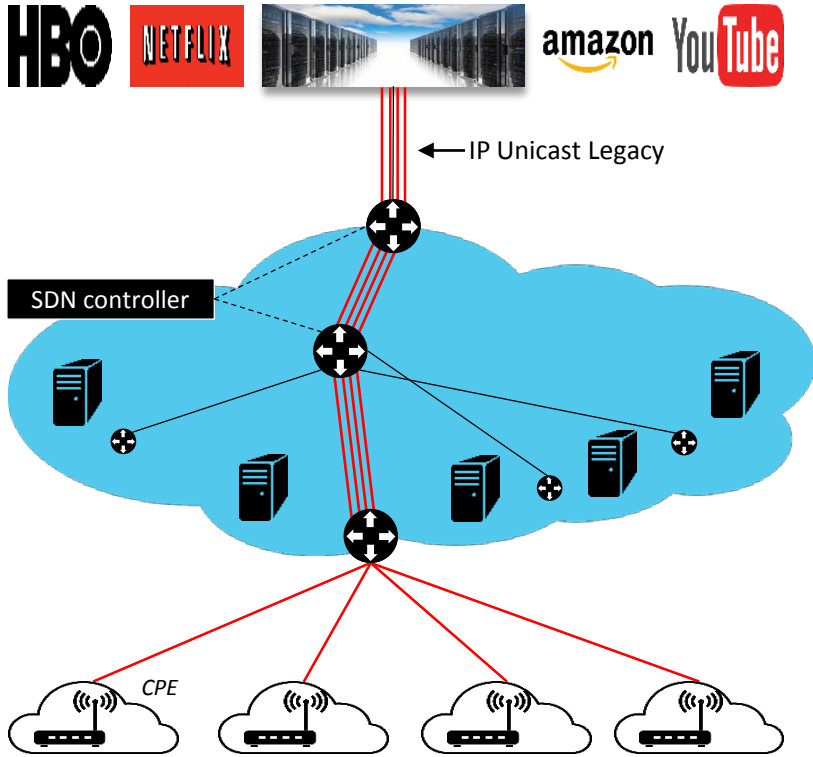
What is Information Centric Networking (ICN)?

- 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!
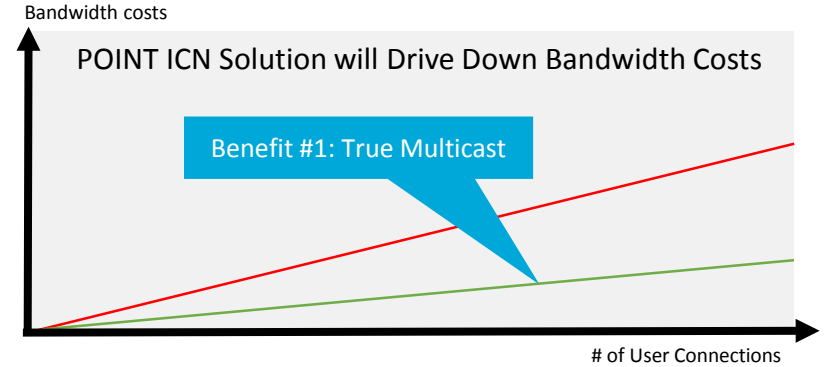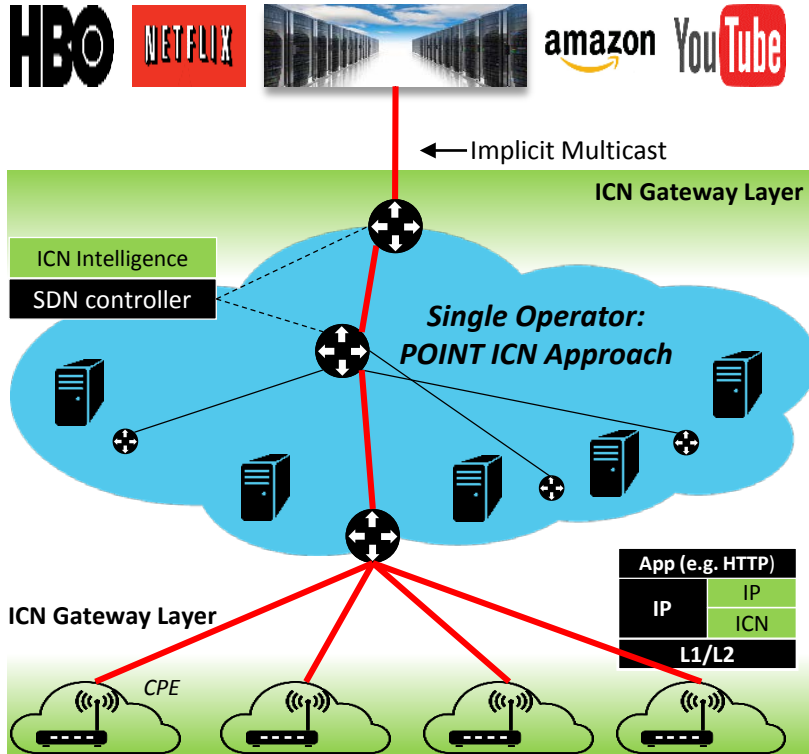- **But** that was before SDN/NFV came along

1980 — Original Arpanet
1990 — CDN — Commercial Internet
2000 — ISP — CDN — Mobile Internet — GGSN
2010 — ISP — CDN — Content-centric Internet
2020+ — ICN

Content Management built into the core fabric of the system

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

http://www.point-h2020.eu/

POINT: A Practical SDN Approach to the Enablement of ICN

Implicit Multicast

ICN Gateway Layer

ICN Intelligence

SDN controller

Single Operator:
POINT ICN Approach

ICN Gateway Layer

CPE

App (e.g. HTTP)

IP | IP
   | ICN

L1/L2

Bandwidth costs

POINT ICN Solution will Drive Down Bandwidth Costs

Benefit #1: True Multicast

# of User Connections

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
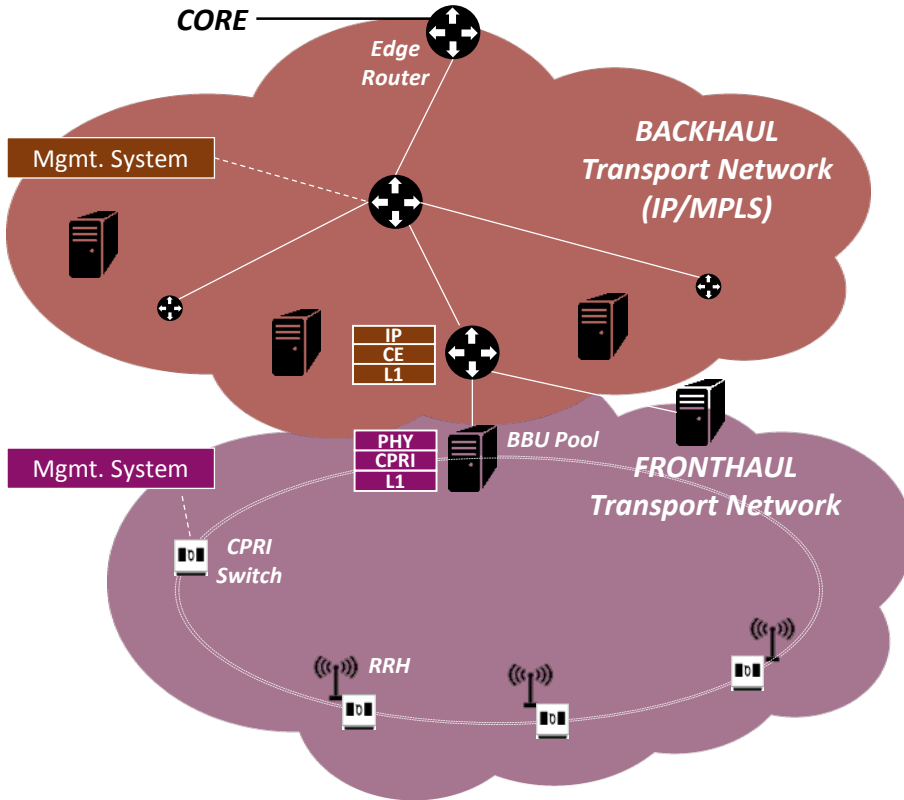
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POINT: A Practical SDN Approach to the Enablement of ICN
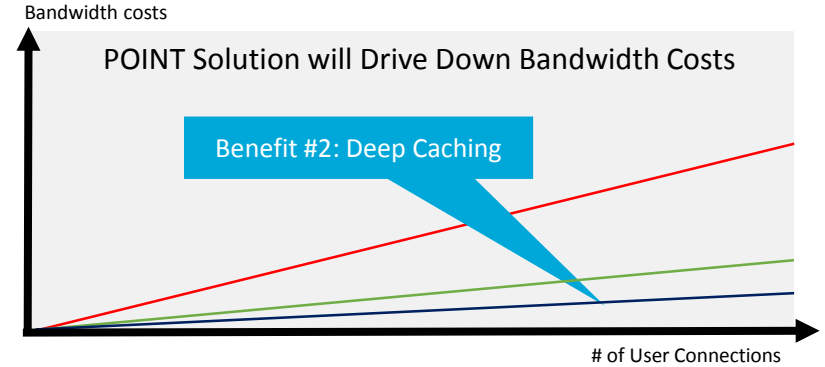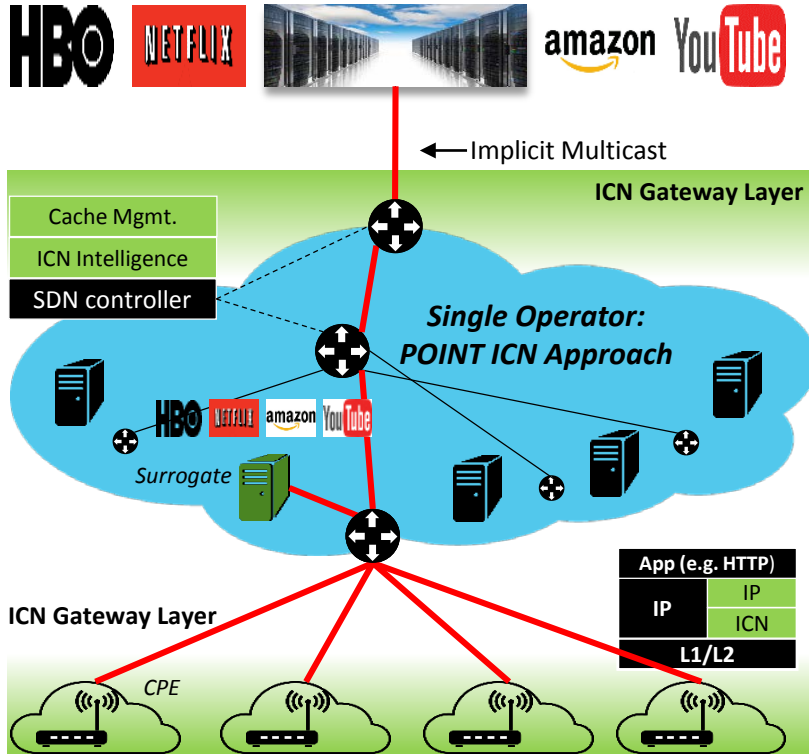
POINT: The next logical step up for deep content caching in dynamic surrogates

- Surrogates are softwarized servers that bring content closer to mobile end users AND create new Caching as Service possibilities for Operators

- Surrogate instances are controlled by SDN/ICN core functions which utilize ICN knowledge about **what** information is requested **where** by how many **users**

http://www.point-h2020.eu/

XHAUL: A SIMPLIFYING Twist on Backhaul and Fronthaul

CORE

Edge Router

Mgmt. System

BACKHAUL Transport Network (IP/MPLS)

IP
CE
L1

PHY
CPRI
L1

BBU Pool

Mgmt. System
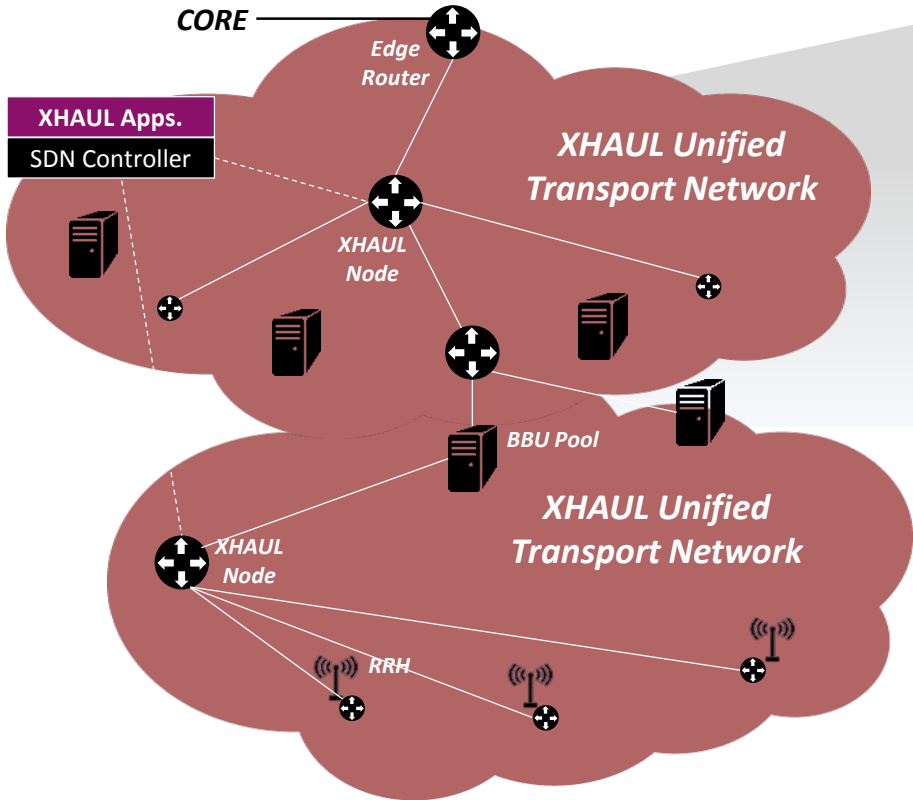
FRONTHAUL Transport Network

CPRI Switch

RRH

Backhaul and Fronthaul Systems have evolved on quite different trajectories

- A wide array of L1-L3 technologies are deployed in todays 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

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XHAUL: An Ambitious SDN Approach for BH & FH Unification

CORE

Edge Router

XHAUL Apps.

SDN Controller

XHAUL Unified Transport Network

XHAUL Node

BBU Pool

XHAUL Unified Transport Network

XHAUL Node

RRH

IP	PHY/BB
Carrier Ethernet	CPRI/OBSAI
XHAUL Common Adaptation & Abstraction	

Radio over Fiber	Passive Optical Network	Wave Division MUX	Micro Wave Link	mmW Link	Free Space Optics

**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
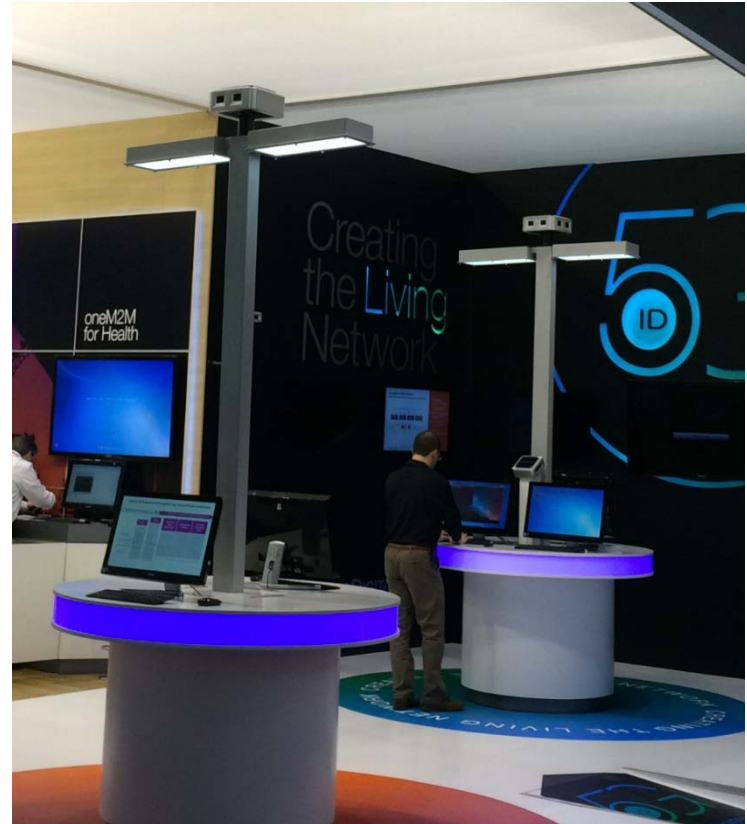
MWC 2015

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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