5G As A User-Centric Network

Xiao-Feng Qi
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5G at Huawei

5G Vision and Viewpoints

A User-Centric View
Huawei Began 5G Research since 2009

- **$600m** for 5G Research (2013~2018)
- **300+** Experts (By 2014)
- **9** Research Centers (By 2014)

**Key Technologies**

- Virtualized RAN
- SCMA
- Full Duplex
- Massive MIMO
- 5G Macro (50Gbps)
- 5G mmWave System (100Gbps)
5G Service Cube

- **100 Billion Links**: Smart Sensor
- **10Gps Throughput**: MirrorSys
- **1ms Latency**: Vehicular Telematics
Network of/for *Humans* and their things – User Experience

The Network of “What”? for “What”?
Contents

5G at Huawei

5G Vision and Viewpoints

👉 A User-Centric View
Case in Point: Video Streaming

• Channel surfing speed is as important as bit rate
• Perception of video quality is content dependent
• Aggregate behavior (e.g. multicast vs. unicast)

Different users have different channel surfing habits, tolerance for perceived QoE, viewing patterns, etc.
A User is More Than Just A Dot

- Physical
  - Speed and trajectory
  - Distribution pattern
  - Surroundings
  - Network RF placement
  - Device capabilities (HW/SW)
- Physiological
  - Sensory response time
  - Cadence of exchange
  - Language difference
- Psychological
  - Content/app preference
  - Service consumption habit
  - Social behavior
  - QoS tolerance

P³ should be learned by both network and devices, as input to a distributed adaptive control loop.

The extra diversity can lead to higher network efficiency and user satisfaction.
Network Impact

User

Psychological

Physiological

Physical

Service specific

Network Enablers

RAN Service Domain

RRM

Scheduling (inc. device resources)

User-centric PHY

SDN

Mobile Edge Network

Learning Across the Network

Mutual Impact
Point to Point: UE follows network

Group to Group: Network follows user

Virtualized RAN

User Centric PHY

Challenges

• CSIT and other feedback signaling overhead does not scale with network density
• Front-haul or side-haul capacity limits

Solutions

• Extract additional user-specific physical information, through machine learning
• User-adaptive beamforming
• Joint access and front-haul optimization
An Expanded View

• 5G network can no longer be a resource arbiter indifferent to nuanced user expectations

• More user centric
  • Customizable objective function, adaptable to dynamic user, service, and network/UE resource availability
  • Uses broader variety of user-specific information for efficient service delivery

• Intelligent feedback loops
  • Machine learning anticipates user behavior
  • Network supports multi-dimensional user feedback

• Expanded analytical framework and problem statements
  • Support for new objective functions for network optimization
  • New network scaling laws incorporating user-centric adaptive control loops

• Cooper vs. Moore
  • Dense network: how to trade signaling overhead for computational complexity?

• Evolution (or punctured equilibrium)
  • 4G network contains most requisite individual dimensions. Holistic integration is needed (e.g. service layer vs. RAN)
  • Evolution or disruption of device intelligence and interaction can not be overlooked
Feedback Loops: From IoH to IoT

- Autonomous mind
- Programmed mind
- Mindless or hive mind?

Human Network
Robot Network
Sensor Network
Thank You

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