SmartEdge: A Computation-Capable and Programmable Wireless Access Network for Content Delivery

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Outline

- Motivation and Industrial Relevance
- Project Objectives
- Approach and Previous Results
- Future Work
- Outcome and Impact
Motivation & Relevance

- IP networks are designed to provide best-effort forwarding services, but in-network services are needed.
  - All kinds of proxies, caches, firewalls… show the demands.

- Trend toward integration of communications technologies and information technologies is creating unprecedented opportunities in design of infrastructure for network-centric services.
  - Rapid growth in cloud computing is an example of such integration.

- SDN is now used for controlling data forwarding, it could incorporate to manage in-network processing.

- Best place to deploy in-network processing capability is at the edge.
  - Processing power and storage become so cheap.

- SmartEdge: A Open Programmable Wireless Access Network with In-network Processing capability.
  - Enable mobile service providers and content service providers deploy the in-network services easily.
This project aims at developing an Open Programmable Wireless Access Network with in-network processing and storage capabilities to provide unified and efficient transport services to users.

- Design architecture and protocol to enable manipulation and transportation of data objects,
  - allows the network controller to automatically identify the data objects and invoke appropriate processing and storage methods on the objects within the network while delivering them.
- Manage and abstract heterogeneous resources (communications, computing, and storage) in the programmable network for unified data processing and delivery at control and orchestration platform.
- Resource allocation to explore the tradeoff among computation, storage, and communication resources within the network for joint optimization;
- Open interface for control, virtualization, and third-party access.
Focused use case: content delivery

- Control wireless networking: media access protocol, channel, transmission parameters.
- Content-aware: control in-network processing and caching based on content characteristics and network conditions
SmartEdge for Wireless Video (1)

- 3GPP DASH content over MBMS + HTTP recovery
- Multicast video transcoding to adapt to receivers’ topology change (Coding as a Service)
  - OpenFlow re-routing
- Local caching
- Virtualized network for “directed” multicast for QoS and security via OpenFlow
  - Beacons or Power Save Multi-Poll (PSMP) to reserve downlink TXOP for multicast
  - Software configured multicast parameters (MCS) at soft AP
HTTP recovery from local cache
Seamless handoff and media follow you
Manipulatable Package (mpackage).

- How does the network controller to identify the data objects and invoke appropriate processing and storage methods on them?
  - out-of-band signaling
  - In-band signaling.

- Manipulatable Package (mpackage): contains an annotation header along with data.
  - The annotation header gives the description and metadata of the user data object in the package.

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<tr>
<th>Payload</th>
<th>mpackage header</th>
<th>IP/TCP Header</th>
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- Given $N$ video streams, how to allocate wireless resource and determine optimal transcoding rate for each stream.
Resource Allocation

- Stream i’s channel access factor: $\alpha_i$
- Its quality: $Q_i(\alpha_i r_i)$
- Several scenarios
  - Equal resource: $\alpha_i = 1/N$
  - Max-min:
    - $\max \{ \min Q_i(\alpha_i r_i) \}$
    - $\sum_i \alpha_i \leq 1$
Controller and Soft AP

- **SoftAP**
  - AP virtualization
  - Operation frequency spectrum
  - Transmission parameters, MCS, TX power.
  - Resource allocation

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Outcome and Impact

- Architecture and protocol design of an Open Programmable Wireless Access Network with in-network processing and storage capabilities.
- Optimal resource allocation algorithm
- Prototype software implementation
- Testbed experimental results

- SmartEdge provides a platform for wireless network service providers and content service providers to deploy new in-network services.
Thanks

Q & A