NetInf Live Video Streaming for Events with Large Crowds

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ABSTRACT

Information Centric Networking (ICN) aims to evolve the Internet from a host-centric to a data-centric paradigm. In particular, it improves performance and resource efficiency in events with large crowds where many users in a local area want to generate and watch media content related to the event.

We present the design of a live video streaming system built on the NetInf ICN architecture and how the architecture was adapted to support live streaming of media content. To evaluate the feasibility and performance of the system, extensive field tests were carried out over several days during a major sports event. Our system streams videos successfully with low delay and communication overhead compared with existing Internet streaming services. It can scale to support several thousands of simultaneous users at a time and is well-suited for events with large crowds and flash crowd scenarios.

Keywords

ICN, NetInf, Live video streaming, Publish-Subscribe, Subscribe-Notify, Point-to-multipoint, Request aggregation, Caching, Flash crowd

1. INTRODUCTION

We demonstrate a live video streaming system built on the NetInf ICN architecture [1, 3]. The system was tested in the field at the FIS Nordic Ski World Championship in February 2015[1] in Falun, Sweden [4]. A smaller scale of this system will be demonstrated at the conference. The audience with Android smartphones will be able to participate.

The system includes many ICN architectural elements such as naming, service discovery, aggregation and caching. The system functionality is implemented on a set of fixed NetInf routers together with a mobile streaming application developed for video recording and viewing on Android phones and tablets.

The system targets the use case at sports events, or more generally, at *events with large crowds*, where people gather in a geographically limited area for a specific time duration with a common purpose and interest. Other examples of such events are concerts, festivals and fairs. The events can take place at dedicated venues, for example, arenas, or take place ad-hoc on the streets of a city or in the countryside.

We argue that ICN technology is well suited for this use case, and especially for supporting live video streaming of the event, both user-generated and officially produced. Video streaming is otherwise very hard to cater for when a large crowd gathers. It is often the case at larger events that the communication infrastructure gets completely overloaded by current cloud-based services, since they need one unicast data stream per client. The situation is a variant of the 'flash crowd' problem that arises when there is a sudden large demand for, e.g., a video. The use case furthermore only needs a limited deployment of ICN technology – there is no dependency on a global ICN infrastructure. Another important use case for ICN technology is in DTN scenarios such as disaster scenarios as it does not depend on any remote network functionality such as cloud services or HLRs. In addition the caching makes previously downloaded material available even after the original sources get disconnected.

[1] `http://falun2015.com/`

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2. NETINF LIVE STREAMING

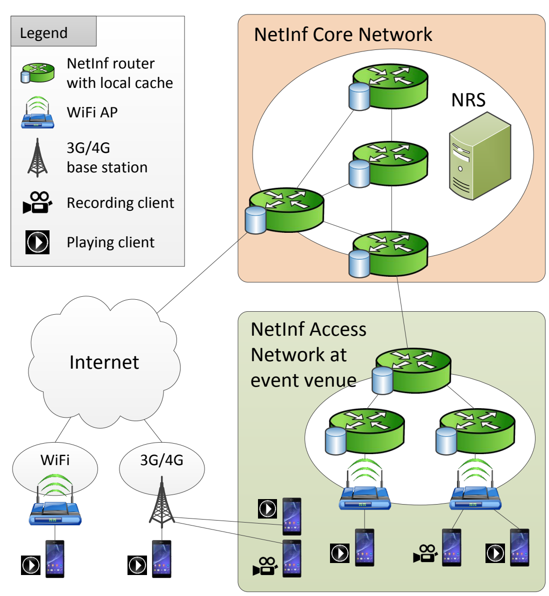

Figure 1: System architecture

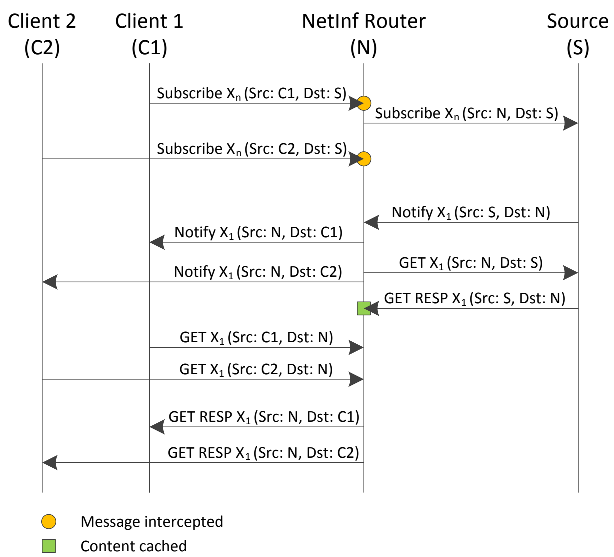

Figure 2: Subscribe-Notify protocol and Content Retrieval

Figure 1 shows the architecture of the NetInf live video streaming system. Users can record and publish video streams at a live event and at the same time other users can watch the streams live. The architecture facilitates streaming to a device anywhere on the internet so that users not present at the venue also can publish or play streams.

Recording and playing clients at the event venue can connect to the system using local WiFi or mobile internet (3G/4G). A client first has to connect to a NetInf router. Consequently this router acts as the first hop NetInf node for the client. Clients connected to the local access network at the event venue via WiFi use Multicast DNS (mDNS) to discover the NetInf router that they should connect to. Clients on the internet connect to a NetInf router in the NetInf core network using regular DNS.

The NetInf core network hosts a Name Resolution Service (NRS). This service is responsible for resolving object names into locators. It also provides search function for the registered Named Data Objects (NDOs). NetInf employs hash-based names as described in RFC6920 [2].

ICN employs ubiquitous caching. Therefore every NetInf router in the architecture is coupled with a local cache. These routers cache NDOs on-path and serve them to corresponding GET requests when there is a cache hit. This ensures that clients are served data from the local network (if the data is cached) and that the edge links (like the one between the NetInf access network and the NetInf core network as seen in Figure 1) are not choked with traffic.

The entire video stream is represented by a single Header NDO that glues together all video chunks of a stream and presents itself as a single point of reference in order to request any subset of a video. The Header NDO contains the metadata for each video, i.e., a description of the video and the geolocation of where the video is recorded. When subscribing to a live video stream, a client in fact sends a subscription request for the Header NDO.

The NetInf live video streaming system uses a hop-by-hop Subscribe-Notify protocol between the requesting client and the data source. Figure 2 illustrates a signaling sequence of the Subscribe-Notify protocol between two clients, a NetInf router and a data source.

The NetInf protocol carried in UDP/IP packets and makes use of legacy HTTP/TCP/IP to transfer large information objects between the nodes in a hierarchically scalable point-to-multipoint tree.

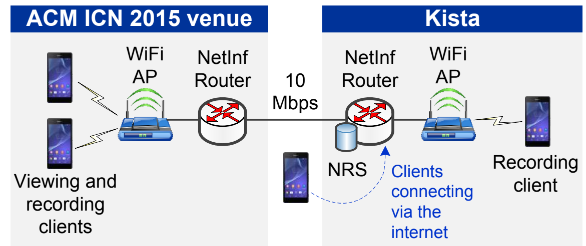

Figure 3: Demo setup

3. DEMO SETUP

Figure 3 shows the setup used for the demo in the ACM ICN 2015 conference. The setup spans across two sites, Kista in Sweden and the ACM ICN 2015 venue.

A NetInf router is installed at each site along with a WiFi access point to facilitate client connections. Clients can record streams at both the sites while several clients can view a specific stream at the ACM ICN 2015 venue. Clients can either connect to the system via the local WiFi access points or can connect via the internet. When connecting via the internet, clients connect to the NetInf router in Kista via DNS resolution of a defined service name. The NetInf router in Kista also hosts the NRS. Traffic exchanged between the two sites is aggregated over a 10 Mbps link. Aggregation is achieved using the hop-by-hop Subscribe-Notify protocol illustrated in Figure 2.

Audience at the demo have the possibility to download the Android NetInf streaming application from a web link and try recording and viewing streams. They can either connect to the local WiFi access point or use mobile internet to use the application.

4. CONCLUSIONS

We have implemented and demonstrated a live video streaming system based on NetInf supporting user-generated content. The system was deployed and field tested at the FIS Nordic Ski World Championship in February 2015. The system worked largely as expected. It proved the viability of the approach, and the relative quality and performance of the implementations.

We argue that ICN-based live streaming systems are ideal for supporting events with large crowds, especially sports events, due to limited deployment needs, and the difficulty to provide enough network capacity for cloud-based services at such events.

5. REFERENCES

[1] C. Dannewitz, D. Kutscher, B. Ohlman, S. Farrell, B. Ahlgren, and H. Karl. Network of information (NetInf)–an information-centric networking architecture. *Computer Communications*, 36(7):721–735, 2013.

[2] S. Farrell, D. Kutscher, C. Dannewitz, B. Ohlman, A. Keranen, and P. Hallam-Baker. Naming Things with Hashes. RFC 6920 (Proposed Standard), Apr. 2013.

[3] D. Kutscher, S. Farrell, and E. Davies. The NetInf Protocol. Internet-Draft draft-kutscher-icnrg-netinf-proto-01, Internet Engineering Task Force, Feb. 2013. Work in progress.

[4] A. M. Malik, B. Ahlgren, B. Ohlman, A. Lindgren, E. Ngai, L. Klingsbo, and M. Lång. Experiences from a field test using ICN for live video streaming. In *Workshop on Multimedia Streaming in Information-Centric Networks (MuSIC)*, Torino, Italy, July 3, 2015. In conjunction with ICME 2015.