CONTENT CENTRIC NETWORKING

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THE MISMATCH BETWEEN INTERNET USAGE AND ARCHITECTURE IN THE INFORMATION ERA

CURRENT TRENDS

• Hundreds of millions of new devices and people are coming online every year

• Data demand is exponentially skyrocketing: 30 exabytes per month

• Consumption patterns are changing, multiple applications/services with severe requirements
THE MISMATCH BETWEEN INTERNET USAGE AND ARCHITECTURE IN THE INFORMATION ERA

LIMITATIONS OF CURRENT SOLUTIONS

• Lack of reactivity
• Coarse granularity
• Off-net approaches
• Puzzle of technologies difficult to interconnect
• Multiple stakeholders with different objectives

INNOVATION AT NETWORK LAYER IS NEEDED TO SUPPORT CONTENT REVOLUTION
TOWARDS NAME-BASED IDENTIFIERS

The limited expressiveness of IP host identifiers has been often debated in the research community, well before the advent of content distributions:

- RFC 1498 “On the naming and binding of network destinations”
- RFC 1958 “Architectural principles of the internet”

It is important to have names (topology-independent identifiers) to:

- Enhance expressiveness for network operations (e.g., routing, forwarding, caching, processing)
- Shield applications from transport/network layer issues (e.g., socket migration)
THE ESSENTIAL CONCEPTS OF CCN

NAME-BASED NETWORK OPERATIONS
Data packets identified by location-independent names: name-based routing, forwarding, caching and processing

CONNECTIONLESS RECEIVER-DRIVEN DATA DELIVERY
No connection instantiation, delivery controlled by the receiver, symmetric routing, multiple sources/paths. Enabled by name-based addressing

IN-NETWORK CACHING
Different use of buffers/memories due to name addressing, temporary caching of popular items for reuse and repair. Enabled by connectionless transport
THE ESSENTIAL CONCEPT OF CCN (CONT’D)

- Objects/services are identified by a globally unique hierarchical name and split into self-identified chunks
- Nodes announce “name prefixes” covering information/service they can provide
- Hop-by-hop multipath name-based forwarding
- Receiver driven connectionless transport protocol
- Caching as extension of buffering for “reuse” and “repair”
CCN MAIN POTENTIAL BENEFITS

- Simplified network management
- Efficient usage of network resources
- Traffic reduction and localization
- Seamless and ubiquitous connectivity
- Congestion reduction

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OUR RESEARCH AGENDA

Design and Evaluation of an end-to-end ICN solution (via analytical modeling, simulations, experiments, software/hardware router prototype)

ICN DEPLOYMENT SCENARIOS (short to long term)

NEW SERVICES enabled by CONTENT-AWARENESS

END-USER PROTOCOLS

IN-NETWORK PROTOCOLS

SYSTEM ARCHITECTURE for CCN and beyond
AGENDA

• Focus on three research works
• Example of relevant deployment scenarios
• Our ecosystem and collaboration with INRIA
FORWARDING MECHANISMS

Main Challenges: define a set of forwarding mechanisms able to exploit available resources and react to dynamic network conditions

Our work:
- Design of adaptive forwarding strategies to discover and exploit temporary replicas
- Joint receiver driven multipath congestion control and in network forwarding strategy
End-host Application Program Interfaces (API) & Protocol stack

**Main Challenges:** introduce an information aware communication model at end-hosts while remaining compatible with existing protocols and standards

**Our work:**
- **API:** interface between application and protocol stack
- **Protocol stack:**
  - Name-based transport (reliability, flow/congestion control, message encaps./decaps. and data demultiplexing)
  - Name-base networking (message encaps./decaps. Packet forwarding and routing)
Main Challenges: very large address space and identifiers of variable and potentially unbounded size

Our work:
- Novel Longest Prefix Matching algorithm
- Distributed design to maximize forwarding table size

Forwarding @ line rate over FIB with tens of millions entries

Design and implementation of a content router:
- Stateful name-based forwarding, high-speed caching
- Compatibility with existing hardware and protocols
OUR EXPERIMENTAL/SIMULATION PLATFORMS

Network Simulator

- Network simulator for Information Centric Networks (open source: http://code.google.com/p/ccnpl-sim/)
- Caching, forwarding, transport and bandwidth simulations.

Prototypes

- Software ICN engine for end host stack.
- High speed hardware ICN engine for network equipments (Routers, Access Points, etc...).

Test-beds

- Distributed test-bed for software prototype(s) on a grid infrastructure with potentially thousands of dedicated servers;
- In lab test-bed for high speed equipments with more than ten physical high speed nodes (i.e. Network Processor, Intel DPDK).
SCALABLE MOBILE BACKHAUL WITH CCN

CURRENT BACK-HAUL INEFFICIENCIES
- GTP tunnels currently turn the backhaul into a pipe
- Traffic engineering is based on capacity planning and over provisioning
- Lack of flexibility, expensive to follow the growing demand, impossible dynamically

CCN BENEFITS
- Enhanced use QoE
- Reduced network operator costs
- Enhanced flexibility
- Knowledge of carried traffic

Higher control for lower cost and novel business opportunity with CCN
CCN MECHANISMS IN CURRENT CDN INFRASTRUCTURE

MAIN CDN LIMITATIONS
• Lack of reactivity
• Additional delay
• Limited flexibility and granularity

MAIN CCN ADVANTAGES
• No DNS dependency
• Enhanced flexibility and dynamicity
• Optimized delivery time
• Reduced server load

Improved CDN performance with CCN mechanisms
INRIA-ALU COMMON LAB: ADR ON CONTENT CENTRIC NETWORKING

Three main research axes:

• **CCN mechanisms/experimentation**
  
  Large scale experimentation of CCN mechanisms (e.g., forwarding, congestion control)
  
  with PLANETE

• **Network-integrated ICN solutions**
  
  Algorithms and protocols for high speed name-based operations and control plane analysis
  
  WITH GANG

• **Information-aware Network Services**
  
  Design, implementation and evaluation of a crowd sourced media curation service based on observed network content footprint
OUR ECOSYSTEM

• Emerging Network Consortium  2012-2014, Industrial Consortium with PARC

• NDN Consortium  2014-on, Industrial Consortium with NDN project and many industrial partners

• Industrial Partnership with Orange Labs  (2011-on)

• IRT SystemX activity (2013-on)

• INRIA/ALU AdR on Content Centric Networking (2013-on)

• LINCS collaborations

• EIT ICT labs experimental activity on ICN 2013 on ICN experimentation

• ICN research group at IRTF

• ANR project CONNECT  2012-2013