Advancing Applications from the Edge In
with Named Data Networking

Lixia Zhang
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ice-ar.named-data.net
NDN-Enabled Secure Edge Networking with Augmented Reality

- Integration of heterogeneous low-level wireless tech. with domain-specific acceleration as a service.
- Robust and resilient networking that comprehensively uses infrastructure resources, also withstand infrastructure failures.
- Transitioning content delivery from monolithic, context-independent streams to highly granular and context-dependent.
- Management of identities and trust relations in dense deployments in large campus networks of the future where content can be generated by all edge devices.
Edge-in Approach

• Target greenfield applications where IP is challenged
• Pursue decentralized computing and communication models:
  • Built on NDN's “fundamentally new abstraction for general purpose networking”
  • Remove cloud dependency for content, processing, rendezvous and trust management
Looking at AR in a different light

“It is widely accepted that creative design is not a matter of first fixing the problem and then searching for a satisfactory solution concept; instead it seems more to be a matter of developing and refining together both the formulation of the problem and ideas for its solution.”

AR as “multiparty context-content exchange”

◊ with a mix of local / global sources, non-binary trust, context-dependent privacy.

◊ Decentralized ecosystem of data and services, seen via various views and filters

◊ Cloud-assisted but not cloud-reliant. The same design works in disrupted infrastructure scenarios (e.g., emergencies).

◊ Names to standardize exchange of data:
  o media; metadata / media descriptions;
  o sensor readings;
  o code; function or service pointers
  o Keys, trust policies

◊ Relationship between names for trust management & rendezvous
Daily Network Usage: campus browser
AR as a Browser: Context <=> Content Exchange

Position tracking of user supplemented by infrastructure based sensing.

Contextual data access based on campus identity information.

Device simultaneous localization and mapping (SLAM) supported by edge accelerated calculations on video stream.

Speech-to-text/intent based navigation accelerated locally based on campus context.

Lights clickable in UI to yield public energy consumption data from building management sensors.

ICN enables effective simultaneous use of multiple radios.

Professor’s “unofficial” repos serve content overlay.

Computer Science Department content overlaid from “official” repos.

Wayfinding hints based on occupancy patterns shared by infrastructure.

Device simultaneous localization and mapping (SLAM) supported by edge accelerated calculations on video stream.

Media suggestions take social network identity into account; media is locally cached.

Computer Science Department content overlaid from “official” repos.

Viewpoint shareable with any number of others, leveraging broadcast capability of NDN and 5G low latency wireless.

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Viewpoint shareable with any number of others, leveraging broadcast capability of NDN and 5G low latency wireless.
The same network remains functional when under stress
Research Challenges

- Naming
- Performance
- Security / Privacy
Naming

Designing the namespace(s):
- Context (and Meta-Context)
- Content (and Meta-Content)
- Keys (Certs)

Considerations
- Supporting discovery of desired data
- Seamlessly embedding edge acceleration
- Leverage benefits of B5G wireless
Performance

Idea

1) Run NDN directly over wireless
2) Name-based architecture for enabling edge acceleration of:
   - Context creation / processing (e.g., location services, SLAM, viewing path, collaborative viewing)
   - Content generation / processing (e.g., transcoding, chunking, rendering)
   - Security primitives (e.g., signing, verification, encryption, group mgmt)

Objectives

- Exploit hardware to speed up AR and NDN security
- Reduce effective latency from network and compute
- Harness heterogeneous wireless link technologies seamlessly
Security

App Desires
1) Decentralize security and avoid cloud dependence;
2) Consistent and expressive new primitives to developers;
3) Spectrum of support for powerful devices to IoT devices

Idea
1) NDN provides signing/verification of each packet as a building block.
2) Security relationships expressed in data names (schematized trust; name-based access control)
3) Named data provides a consistent way to share keys, certs, and context.

Objectives
• Provide scalable trust management in a coherent framework
• Localize the impact of security compromises
Conclusion

Model of AR

- Web of named data to be browsed
- (decentralized) Multiparty context-content exchange
- Security built in; privacy as contextual integrity.

Role of AR applications

- Drive NDN architecture development for wireless edge networking

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