Industry Panel at

1st workshop on

Information-Centric Fog Computing

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Adoption Challenges and Prospect of ICN Fog Computing

Topics

1. **Motivation and feasibility of ICN edge/fog computing**
   - Why is this a good idea? Why not?
   - What are expected benefits?
2. **Challenges for ICN edge/fog computing**
   - What are the most important challenges in your opinion?
     - Research challenges
     - Deployment challenges
3. **Outlook: Deployment**
   - Most promising use cases (if any)?
   - Most promising approach (architecture, specific technology etc.)?

Adoption Challenges and Prospect of ICN Fog Computing

Panelists:

- **Eve Schooler** (Principal Engineer and Director, Intel IoT)
- **Dirk Trossen** (Senior Principal Engineer, InterDigital Europe)
- **Chris Wood** (Researcher, University of California Irvine)
- **Cedric Westphal** (Principal Research Architect, Huawei)

Eve M. Schooler

Principal Engineer & Director, Research in Emerging Architectures

- **Affiliation**: Internet of Things Group, Intel
- **Interest/research in ICN & Edge/Fog:**
  - Fog architecture, ICN in IoT / smart spaces, Data privacy, Reverse CDNs, Smart Objects in Fog computing, Trust models, ICN in Wireless Edge Networks, Remote interaction and control of real-time IoT data and devices, Anomaly detection
- **Mission Statement:**
  - Disrupt the status quo, bridge the divide between research and Intel business units, make Fog less Foggy

Dirk Trossen

- Senior Principal Engineer @ InterDigital Europe
  - Started 2013, leading network team in London office
- Started ICN research in 2007
  - Led numerous ICN pprojects
    - Technical Manager PSIRP & PURSUIT FP7 project
    - Technical Manager POINT & FLAME H2020 project, arch lead RIFE H2020 Project
  - Interest in architecture, routing, naming, … building workable systems

Mission statement: ***if we make the Internet work (better) over ICN, it will be the best use case for ICN ever!***

Christopher Wood

- Affiliation: UC Irvine
- Current research interest: privacy in ICN
- Mission statement: Make ICN secure and private by default with the ability to opt-out

Cedric Westphal

Affiliation:
Huawei Technology, Santa Clara, CA, USA

Computer Engineering Dept, University of California, Santa Cruz

Interests:
AR/VR and video distribution in ICN networks
Content-based Traffic Engineering, resource allocation and management
Caching algorithms and policy
Graph properties of ICN networks

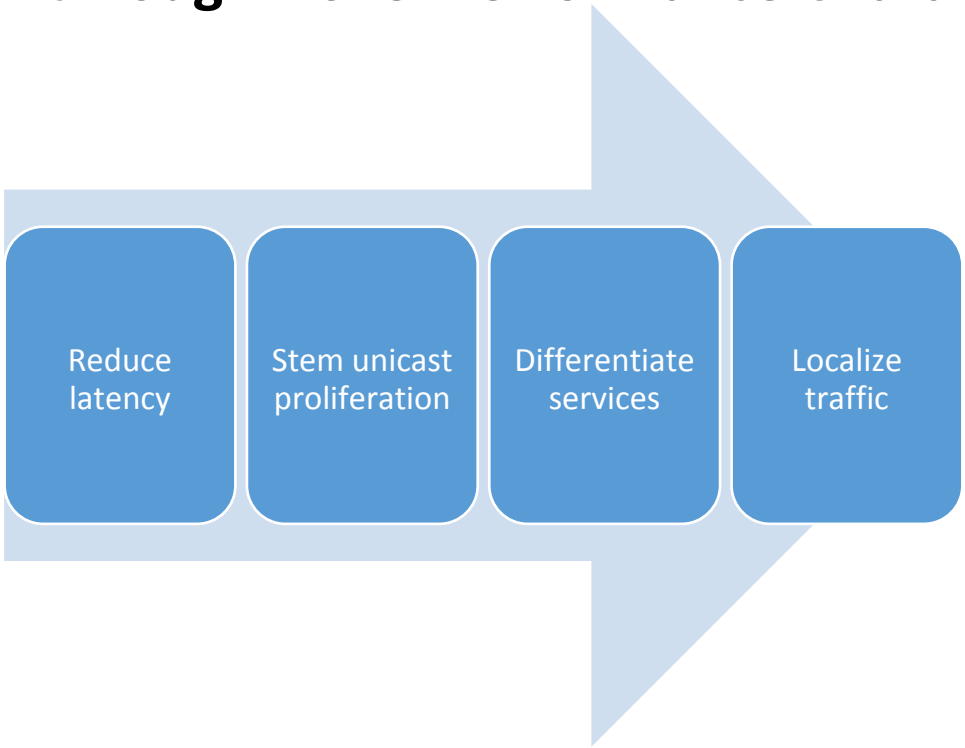
Mission Statement:
Can we turn ICN into actual products?

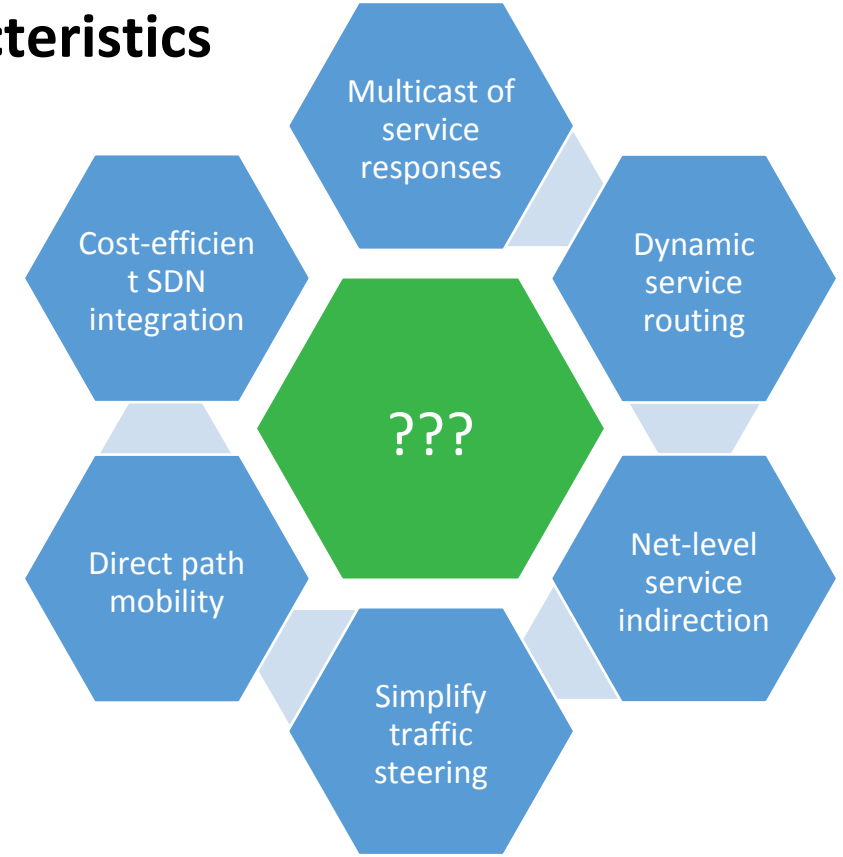
Motivation and feasibility of ICN edge/fog computing

Mission & Feasability of ICN Edge/Fog Computing

- **Why is this a good idea?**
  - Not a bad idea. ICN proven useful intra-cloud comms for IoT. Why not E/W and N/S, too?
  - Edge/Fog needs a transport to bring “compute to the data”, something data-centric.
  - ICN already provides routing and caching capability, why not processing too?
- **Why not?**
  - Is ICN uniquely positioned to provide this service?
  - Can it play well with other IC technologies?
  - Data availability in a tussle with data privacy – not sure ICN up to task, yet.
- **Expected Benefits?**
  - Converged networking/compute/storage Fog nodes

Motivation for ICN-based Edge: Meeting 5G Requirements through Novel Performance Characteristics





Chris: Motivation and Feasibility

The good:

- Current (secure) connection-based transport is architecturally restrictive
- ICN collapses many layers in the stack
- Authenticity is a core architectural feature
- ICN consumers are often ghosts*

The bad:

- Formulating meaningful definitions of privacy is difficult
- Applications are ultimately responsible for privacy -- what if they accidentally opt out?
- Consumers (and applications) are often “noisy”

Cedric: Motivation and Feasibility

- AR needs:
  - FAST access to content with strong locality
    - Content needs to be distributed nearby
  - Processing functions nearby
    - For instance, to extract features from user's field of view
  - Information and processing can be shared between users
- ICN and fog answers some of these requirements
  - Depending on how you define these...
- Feasibility is TBD…
  - Or: can it be provided over current architecture at the application layer?

Challenges
For ICN edge/fog computing

Challenges for ICN Edge/Fog Computing

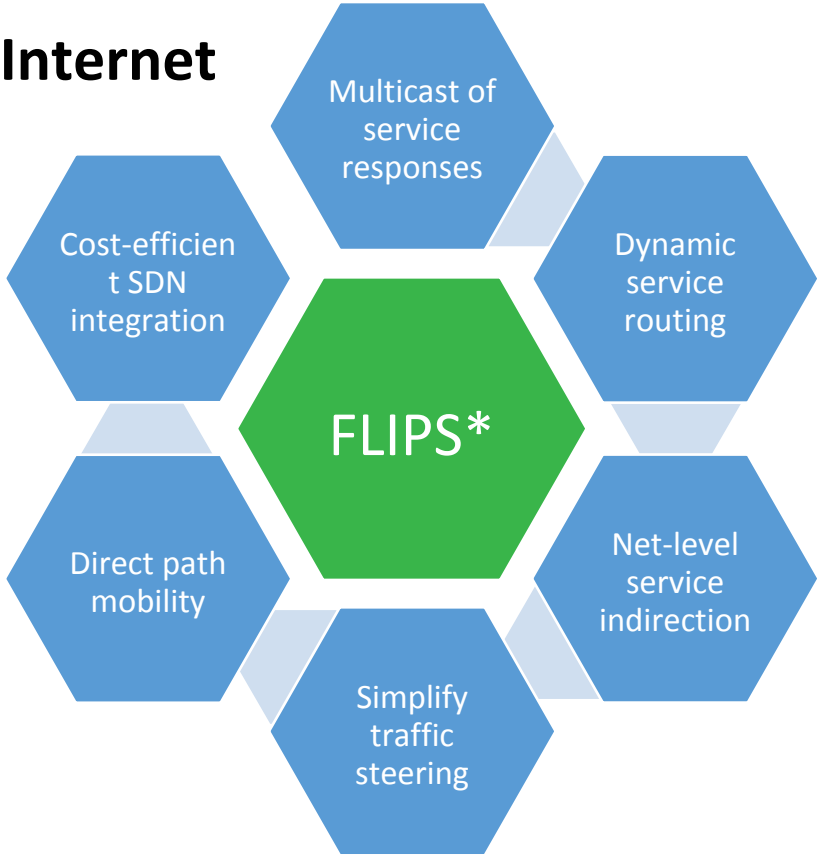
- **Most important Research challenges**
  - Does it work at IoT scale? Naming, routing, security, privacy, trust
  - ICN and the Mobile edge
  - ICN for software-defined Fog
  - Support for service orchestration
- **Most important Deployment challenges**
  - Ease of use for: developers, integrators, administrators, … users
  - Simplicity of setup
  - Interoperability with other flavors of ICN and IP, w/broader eco-system

Challenges: Brave New World or the Internet (over ICN?)

New service API(s) or based on HTTP (and other IP-based protocols)?

- If new service API(s), what services?
  - New? Old ones but better?
- If backward compatible
  - Most 5G edge transports are (SDN) L2
    -> **service routing over L2** (SROL) problem
  - Need mapping of HTTP to ICN

  -> Use solutions developed in POINT project
  - Possibly provide performance benefits unseen in IP networks



*FLIPS (Flexible IP Services) is a platform based on POINT & RIFE H2020 project solutions

Chris: Challenges

- Data-centric security shifts burden of security and privacy to applications.
  - TLS does not give us the best privacy
  - Are ICNs better or worse off?
- Giving applications maximal flexibility of name-to-data bindings without allowing them to harm themselves
  - IoT data (names) can be very specific and illuminating
- Meaningful separations between “what is requested at the application layer” and “what packet is sent over the wire” that maintain privacy
- Privacy-preserving data models and application design patterns
  - How can applications transfer or obtain data without leaking sensitive information?

Cedric: Challenges

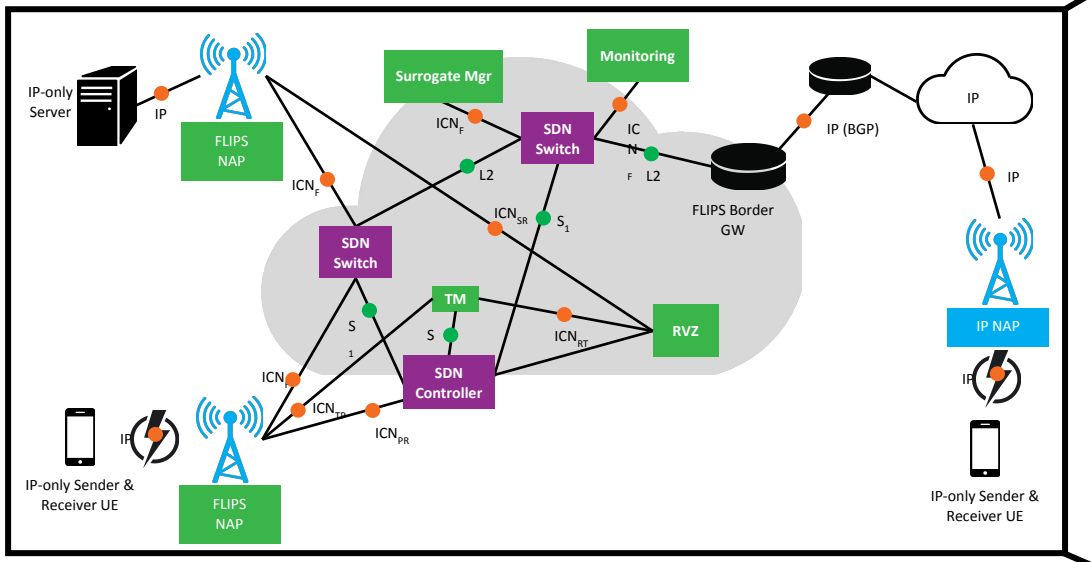
- How to build an infrastructure to support the AR fog use case?
- What naming? What distributed security mechanisms? What caching? How to share in between users?
- Can the gains be achieved without new architecture?
  - Market research says AR will be $$$ in 2020, and I'm assuming they have not included a new post-IP architecture in this valuation...
- What is a fog network (who exactly is Karl?)

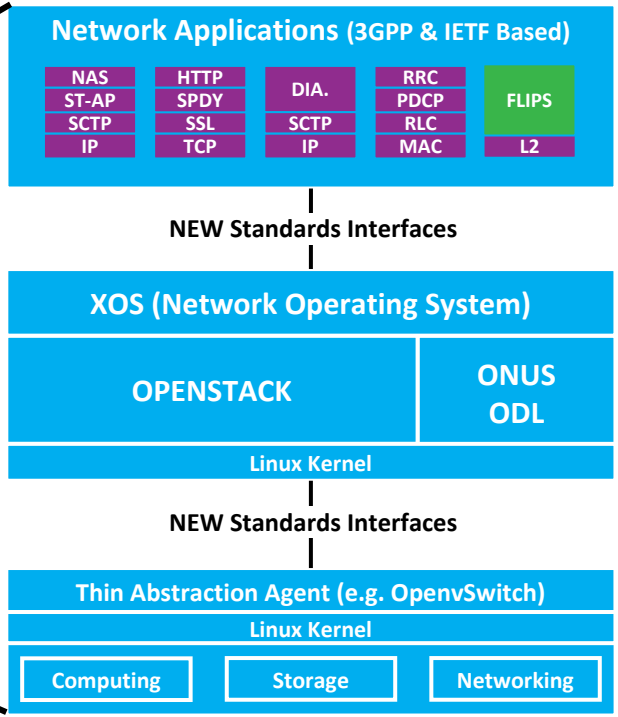
Outlook: Deployment?

Deployment Outlook

- **Most promising use cases?**
  - Video/Audio analytics & surveillance – it is already here, already needed
  - AR/VR – commercial promise
  - Autonomous driving – from an impact standpoint
  - Smart cities – it's where over ½ the population will live
- **Most promising approach (architecture, specific technology, etc.)?**
  - Participate in and influence IoT and Fog standards
  - Balance getting it done with IoT for Social Good

Outlook: Deployment as a Net App





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Chris: Outlook

- ICN is not about caching
  - Stack revolution and simplification is a huge win
  - Symmetric traffic flow and in-network signals are a huge help for newer transports
- Not enough attention paid to privacy
- Security and privacy should be core features
  - TLS is the thin waist today
  - Applications should not be trusted entirely

Cedric: Outlook

- Clouded with a chance of fog in the evening
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- Work in standardization in AR/VR and ICN
- IoT driven fog computing but video a component of this
  - And even AR, say in a surveillance use case
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Questions?
Comments?