

## **Information Centric Networking - an Insight into Architecture and Caching**

### **Abstract**

Information Centric Networking (ICN) has been proposed as alternate design architecture for the Internet. ICN advocates a paradigm shift from host centric approach of current Internet to the content centric approach of the future Internet. ICN provides significant improvement over the current Internet in terms of bandwidth utilization and content latency. ICN architecture inherently solves various challenges related to security, multicasting of content and producer mobility far more efficiently than the current Internet architecture. Like architecture, strategic caching of contents also plays an important role in the performance of ICN. In this tutorial, we intend to discourse various architectural design challenges, proposed alternative architectures to Internet, caching schemes which can improve the performance of ICN networks, naming schemes which can impact the performance, scalability, security and privacy etc.

### **Motivations and Timelines**

This tutorial is motivated by the challenges faced by the current Internet and introduces Information Centric Networking (ICN) as a new architectural paradigm for the Internet. In this tutorial, we will discuss various challenges and features of ICN and discuss how the challenges of the current and future Internet will be addressed using ICN.

This tutorial is intended for everyone who believes that the current Internet was not originally envisaged for the kind of applications and data transfers it is predominantly being used today. We strongly feel that this tutorial on ICN will definitely benefit the researchers, students, developers, industry personals, Internet Service Providers (ISPs), and telecom operators to a large extent.

### **Background and Scope of the tutorial**

ICN is being proposed as an alternate approach to reduce the redundant data transmissions in the network. The principle of ICN says that the network should be data-centric rather than host-centric, i.e., a communication network should allow users to focus on the data, while the network itself should be able to service the request with minimal strain on its resources. At the same time, since existing Internet architecture has become deeply rooted and complex, it is not possible to have a clean slate architecture for the future Internet. Hence, any proposed solution should be incrementally deployable as an overlay network without bringing any significant impact on the existing infrastructure/functionalities and should also be able to address the twin problems identified above thoroughly. The scope of this tutorial is to discuss and present the current state of the art and the research directions on the following broad areas:

- ICN Architecture Design – Proposed architectures, architectural challenges, overlay network architecture to support ICN co-existing with the Internet (O-ICN), SDN based approach for ICN architecture, *ns3* based architectural model for research on ICN, security and trust related issues related to architecture. Handling Multicasting and Mobility using ICN paradigm.
- Naming, addressing and routing schemes – Various proposals, their pros-cons, industry trends on ICN naming, addressing and routing will be discussed.
- Caching techniques in ICN - Need of ICN caching, existing techniques, along with our proposed universal caching, distributed caching, and hierarchical caching techniques, implementation challenges, simulation and test scenarios, etc., will be evaluated.

We also plan to discuss various deployment scenarios and critically analyze them in the course of the tutorial.

### **Prior history of the tutorial presentation**

We had a half day tutorial on Introduction to ICN in **IEEE ANTS 2014** conference. It was attended by more than **20 participants**.

We strongly believe that the current Internet architecture needs to be revisited and redesigned to satisfy the altered demands of the modern users. ICN has been envisaged as a potential candidate for the future Internet.

## Topic to be covered and the duration

We propose a **half-day tutorial** on ICN with a break-up as follows:

1. Introduction to the tutorial theme	20 min
2. Challenges with ICN approach	20 min
3. Architecting ICN – an overlay network design and other approaches	40 min
4. Caching in ICN	40 min
5. Naming in ICN	30 min
6. Use cases	20 min
7. Discussions/Way forward	20 min

## Short biography of the instructor

**Anantha Simha** - Anantha, Member IEEE, is a Post Graduate in Electrical Engineering from IIT Madras, India and BE in Digital Electronics from University of Bangalore, India. He has 30+ years of experience in industry in the areas of microprocessor based hardware design, embedded protocol software, enterprise network design, network optimization, performance analysis, data center network design, Software Defined Networks (SDN), etc. For the last 20+ years he has been working with TCS. Currently he is heading the Networks Lab, Bangalore under CTO organization of Tata Consultancy Services (TCS). His current research interests includes: QoS in Networks, Scheduling, Self-Optimization, Large Scale Network Design, Cloud Computing, Software Defined Networks, ICN Architecture Design, Next Generation Networks etc. He has published many research papers in national and international conferences/seminars such as IEEE ICC, Globecom, NCC, ANTS, COMSNETS, PIMRC, CSNT, etc., and has filed several patents through TCS in the areas of communication networks. Anantha has presented in various technical events, and is actively involved in standardization activities through TSDSI (Indian SDO) and GISFI.

**Dr. Hemant Kumar Rath** - Hemant, Senior Member IEEE and IARCS, holds MTech (2004) and PhD (2009) from IIT Bombay, India (Communication Engineering) and BE in EL&TCE (1997) from VSSUT Burla, Sambalpur, Odisha. He has close to 15 years of experience in academics, research and industry. At present, Hemant is a Senior Scientist at TCS Networks Lab, Bangalore since Dec 2010. Hemant was also working as an Associate Professor at KIIT Bhubaneswar (2009-10), a premier academic institute in India, an Associate Manager (2000-02) in UACT (a joint collaboration of Usha Martin with IIT Madras) and Scientist (1998-2000) at CEERI Center, New Delhi. His current research interests include: QoS in Networks, LTE/WiMAX Scheduling, Self-Optimization, Propagation Model Design, M2M Communication, Cloud Computing, Information Centric Networks, Software Defined Networks, etc. He has published many research papers and presented many talks in national and international conferences/seminars such as IEEE Globecom, ICC, COMSNETS, NCC, PIMRC, ACM ICDCN, ITU-T, BWCI-COAI Workshop etc., and has filled several patents through TCS in the areas of communication and networks. Hemant has extensive knowledge and experience in network modeling, algorithm design, stability analysis, kernel level programming, simulations using Matlab, NS2, NS3, Qualnet etc. Hemant has also served as Industry Panel Speaker at ICC 2012 (Toronto), IEEE COMSNETS 2013 (Bangalore), ACM Sumo-CPS, etc. He has also served as PhD examiner at IITs, NITs and other Indian Universities and has also served as technical program committee members of international research workshops in the area of cyber physical systems such as ACM SUMO-CPS 2013, Networking Track of IEEE NCC 2013-15, IEEE COMSNETS 2013 etc. He is also participating in national and international standardization activities (IoT – GISFI, IoT – ITU-T, TSDSI and 3GPP) in the areas of networking and communications. Hemant is also actively involved in academics and is in the board of studies of several colleges in India.

**Dr. Samar Shailendra** – Samar, member IEEE, ComSoc and ACM, is working as Scientist in CTO Networks Lab, TCS Bangalore since Oct 2013. He is at the visiting faculty list of IIIT Bangalore and also serving as Vice Chair of M2M Work Group at TSDSI. He has more than 11 years of Industry and Academic experience in the areas of Wired and Wireless Networks. At TCS, he is currently working in the areas of Network Virtualization, Data Center Design, ICN design and architecture, Multipath transport etc. and is leading a team of researchers in these areas. Prior to joining TCS, he was pursuing his PhD at IIT Guwahati under the guidance of Prof. S. K. Bose and Prof. R. Bhattacharjee. Samar has also worked on Novell Audit and developed a product called Platform Agent at Novell Software. He was also part of architecture team of Finacle, a universal banking solution from Infosys. During 2002-05, Samar was into academics and served as faculty at IIIT Noida and MITS Rajasthan where he has taught undergraduate and postgraduate courses and guided several undergraduate and graduate thesis. Samar has obtained his M.Tech and B.Tech degrees from IIT Delhi and IET Lucknow respectively. Samar has published several papers in various reputed Journals and IEEE Conferences such as IEEE

PIMRC, IEEE ANTS, IEEE ICCS, IEEE ICICS and served as TPC member in various international conferences. Samar has filed 5 patents in the area of Information Centric Networking.

**Dr. Bighnaraj Panigrahi** – Bighnaraj is currently working as a Researcher at CTO Networks Lab, TCS Bangalore. At TCS, he is working in various projects in Wireless Networks such as Information Centric Networks (ICN), Device-to-Device (D2D) communications, and WiFi offloading, etc. Before joining TCS he was a Research Scientist-I at SDSMT, USA, and was working there on a NASA funded project on Delay Tolerant TCP protocol for Deep Space Communications. Panigrahi holds a BSc degree in Physics and two Master degrees (MSc and MTech) in Electronic Science and Computer Science, respectively. He obtained his PhD from IIT Delhi (2012) where he worked on cross-layer optimization problems in Wireless Sensor and Ad-hoc Networks. He has research experience of more than 7 years in different fields of wireless networks such as Wireless Sensor and Ad-hoc Networks, Deep Space Communications, Cognitive Radio Networks, Information Centric Networks, Cellular and LTE Networks, etc. He has keen interest in performance modeling, cross-layer optimization, theoretical modeling, simulation and test-bed implementation, etc. Panigrahi also has academic interests and was working as an Assistant Professor in IMS Engg. Colg, UP, India, where he taught several courses in the areas of computer science and guided several Bachelors and Masters students. He has several national and international conference and journals papers to his credit and recently filed several patents in the area of Information Centric Networks (ICN) and D2D Communications. He is a reviewer for several reputed conferences and journals. He also served as a TPC member for IEEE ANTS 2014, ICIT 2014, and ICDCIT 2015. He is also actively participating in standards' bodies like TSDSI and 3GPP (through TSDSI).