T5 (Half day, Morning, 9 November 2005)

Session Initiation Protocol (SIP): A Protocol for Supporting Multimedia in Next Generation Networks

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Abstract:

This tutorial will describe the transformation of circuit-switched telecommunication networks to a packet-based network currently underway in a global scale and the central role of SIP (Session Initiation Protocol) in this transformation. This transformation is occurring in both wireline and wireless service provider networks, as well as in enterprise networks, with Voice-over-IP (VoIP) as the most visible effect of this transformation. Networks built from monolithic switching systems are giving way to organically built networks based on SIP. The building blocks of NGN comprise standard server hardware and software, with open interfaces that allow network managers to mix-and-match SIP components from multiple vendors. In addition, SIP clients are becoming standard components of important client platforms (such as Microsoft Windows and J2ME-enabled cellular phones). This is already evident in new applications enabled by SIP, such as IP Softphones and Instant Messaging clients on desktop machines and Push-to-Talk client on mobile phones. This tutorial will cover the fundamental shift in voice networks due to SIP, protocol-level description of SIP, new applications that leverage SIP (such as Instant Messaging or device control), programming interfaces for building SIP-based network services, current standardization efforts and open-source projects. This tutorial is intended for R&D professionals in industry as well faculty members and graduate students from academic institutions.

Tutorial outline: (list of topics)

- INTRODUCTION [1 Hr]
  - Brief Overview of SIP
    - Introduction to VoIP, Instant Messaging & Push-to-talk
    - Historical perspective (H.323)
  - Role/Impact of SIP in Next Generation Networks
    - Service Provider Networks (PSTN, Data operators)
    - Mobile Operators
    - Enterprise Networks
    - 802.11 Hotspots
  - Comparing SIP and PSTN
    - Circuit-switched model of PSTN
    - Overlay network of SIP servers and software
    - Moving intelligence from the core to the edge
  - SIP in relation to Web / HTTP
    - Client-side converged applications
    - Server-side integration
  - SIP devices
    - IP Phones, Softphones, WiFi SIP phones

        - Softswitches
        - Media gateways

- TECHNICAL DESCRIPTION [1.75 Hrs]
    - SIP Protocol Architecture
        - Architectural Principles
        - Place of SIP in the IP protocol stack
        - Naming, Message structure, Message Types and functionality, Message flows
        - SIP building blocks : User Agents, Proxy, Redirect Servers, Location servers, Back2back user agents
        - Message Routing
        - Call flow examples
        - Supporting protocols : RTP, RTCP, RSVP
    - Enabling Voice-over-IP (VoIP) with SIP
        - SIP based VoIP Architecture
        - Integration with PSTN
        - Call flows
        - Examples of new service providers offering VoIP
        - AAA (Authentication, Accounting and Authorization) and Security with VoIP
    - Use of SIP for Instant Messaging and Presence (SIMPLE)
        - Messages for IM and Presence
        - Publish/ Subscribe mechanisms
        - Event packages
    - Security Issues
        - Authentication and User Identity
        - Firewalls, Border Session Controllers
        - Anonymity Preferences
        - Privacy Architectures and Preference Processing
    - Managing SIP-based Networks and Devices
        - Load-Balancing and Dynamic Routing
        - SIP extensions for Device Control

- SIP in ACCESS NETWORKS (0.5 hour)
    - SIP in 3G networks
        - 3GPP and 3GPP2 architecture overview (IMS)
        - IP based call control
        - Use of SIP for
            - Presence and Push-to-talk
    - VoIP over wireless LANs
        - Architecture
        - Integrating wireless LAN and 3G
    - SIP over Residential Broadband Access
        - Vonage, AT&T’s CallVantage, Cable operators

- PROGRAMMING INTERFACES TO SIP [1 Hr]
  - SIP servlets and SIP-CGI
  - JAIN-SIP APIs, PARLAY APIs
  - J2ME Specifications
  - Interaction with Web Services

- STANDARDS ACTIVITIES AND EMERGING TOPICS[1.5 Hrs]
  - IETF Working Groups : SIP, SIMPLE, SIPPING, XCON, GEOPRIV
  - 3GPP and 3GPP2
  - SIP in peer-to-peer networks
  - Use of SIP in multi-player networked games

- OPEN-SOURCE SIP PROJECTS [0.5 Hrs]

- SUMMARY and CONCLUSIONS

Intended audience:

The intended audience includes industry professionals as well as graduate students and faculty members from the academia looking to understand the basics of NGNs and related applications. The tutorial is expected to be especially helpful to telecommunications or IT practitioners wishing to understand the technical details of SIP. The audience is expected to be familiar with the basic IP protocol stack and the function of services such as DNS, routing etc.

References or supplemental materials:

Selected Publications related to SIP

- SIP-based Mobility Architecture for Next Generation Wireless Networks. N. Banerjee, S. Das and A. Acharya.3rd IEEE International Conference on Pervasive Computing and Communications (Percom), 2005.

- Using Session Initiation Protocol to build Context-aware VoIP support for Multiplayer Networked Games. A. Singh and A. Acharya. ACM Workshop on Network and Systems support for Games (NetGames) 2004..

- Design and Implementation of SIP Network and Client Services for enabling Collaborative Applications. A. Singh, P. Mahadevan, A. Acharya, Z. Shae. 13th Intl Conference on Computer Communication and Networks (ICCCN) 2004.

- Unleashing the power of Wearable Devices in a SIP infrastructure. S. Berger, A. Acharya and C. Narayanaswami. IBM Research Report RC 23288. Percom 2005.

- Enabling SIP-based Session Setup in Ad Hoc Networks. N. Banerjee, A. Acharya, S. Das. IBM Research Report RC 23270. Submitted to Infocom 2005.

- Peer-to-peer Instant Messaging and Presence Services over Wireless Ad Hoc Networks. N. Banerjee, A. Acharya, S. Das. 1st Intl Workshop on Broadband Wireless Multimedia (BroadWiM), 2004 in conjunction with BroadNets 2004.

- Misra, S. Das and P. Agrawal, Application-Centric Analysis of IP-based Mobility Management Techniques, Journal of Wireless Communications and Mobile Computing, Wiley Interscience, Volume 1, Issue 3, August 2001 (ISSN: 1530-8677).

- S Das, A Mcauley, A Misra and S K Das, A Comparison of Mobility Protocols for Quasi-Dynamic Networks, Proceedings of IEEE Wireless Communications and Networking Conference (WCNC), September 2000, Chicago, USA.

IETF Internet Drafts

- A Houri, T. Hiller, A. Audu, T. Hansen. SIP/SIMPLE Based Presence and IM Architecture (http://www.ietf.org/internet-drafts/draft-houri-simple-arch-02.txt)

- P. Saint-Andre, A. Houri, J. Hildebrand. Interoperability between the Extensible Messaging and Presence Protocol (XMPP) and Session Initiation Protocol (SIP) Extensions for Instant Messaging and Presence (http://www.ietf.org/internet-drafts/draft-saintandre-xmpp-simple-01.txt)

- O. Levin, A. Houri, A. Aoki. Inter-domain Requirements for SIMPLE (http://www.ietf.org/internet-drafts/draft-levin-simple-interdomain-reqs-01.txt)

Related Patents (Awarded/ Filed) related to SIP

Patents filed by Arup Acharya:

a) Method and apparatus for integrating wearable devices within a SIP Infrastructure. Filed Aug 2004.
b) SIP based VoIP MultiPlayer Network Games. Filed Feb 2004.
c) System and apparatus for geographically distributed VoIP Conference Service with Enhanced QoS. Filed Oct 03.
d) Enabling Collaborative Applications using Session Initiation Protocol (SIP) based Voice over Internet Protocol Networks (VoIP). Filed Oct 03)
e) A method and apparatus for providing quality of service to VoIP over 802.11 wireless LANS. Filed Nov 03.
f) Differentiated handling of SIP messages for VoIP call control. Filed Nov 03.

Patents by A. Houri:

a) WO0073919A1: VISUAL INDICATOR OF NETWORK USER STATUS BASED ON USER INDICATOR

Recent patents filed by Archan Misra :

a) Method for Establishment and Maintenance of Collaborative Associations based on Multiple Contextual Criteria . (Filed Feb 04)

Instructor's tutorial experience

Arup Acharya's tutorial experience : ACM Mobicom 1997, l "Wireless ATM : Standards, Architectures, Protocols and Implementation, Full-Day Tutorial, Sept 26 1997, Budapest, Hungary. Jointly with Dr Delaverson, Dr CK Toh.

Archan Misra's tutorial experience:

- MOBWISER (Workshop on Mobile, Wireless and Sensor Networks), March 2004, Singapore, Half-day Tutorial "Research Challenges in High Performance Wireless Multi-Hop Networks"
- ICON (Intenational Conference on Networking), October 2003, Sydney, Multi-Hop Wireless Networks: Current Trends, Research Direction and Challenges (jointly with Dr. S. Banerjee and Dr. S Mohapatra)
- HiPC (International Conference on High Performance Comptuing), December 200, Bangalore, IP-Based Mobility Management Techniques (jointly with Dr. S. Das).

Instructor's biography

Dr Arup Acharya works in the Network Server Systems Group at IBM T.J. Watson Research Center and also leads the Advanced Networking micropractice in On-Demand Innovation Services. He has been working on SIP for the past three years, through research projects, customer consulting engagements and providing subject matter expertise in corporate strategy teams. Presently, he is leading a IBM Research project on scalability and performance of SIP servers for large workloads. His other projects enabling SIP-based applications, controlling wearable devices using SIP, role of SIP/ SIMPLE in multi-player networked games and location-based services such as e911. He is involved with a joint industry/academia NSF project on a testbed for next generation wireless networks, where he is investigating peer-to-peer SIP architectures and mobility control architectures for dual-mode devices.

His other interests include networking architectures such as IPv6 and wireless mesh networks. He has published extensively in conferences/journals, and is currently the Vice-Chair of IEEE ICDCS 2006 and IEEE MASS 2005. He was the past co-chair of the Global Internet and Next Generation Networks Symposium 2004. He has been awarded five patents and has also contributed to standards bodies such as the IETF and ATM Forum. Before joining IBM, he was

with NEC C&C Research Laboratories, Princeton between May '95 and Nov'99. He holds a Visiting Professor position at WINLAB, Rutgers University. He received a B.Tech degree in Computer Science from the Indian Institute of Technology, Kharagpur and a PhD in Computer Science from Rutgers University in 1995. Further information is available at http://www.research.ibm.com/people/a/arup/

Dr. Archan Misra is a Research Staff Member with the Next Gen Web Infrastructure Department at the IBM TJ Watson Research Center, Hawthorne, NY. He has been working on infrastructural components and protocols for context-based computing and pervasive applications for the past 3 years. In particular, he works on IBM's mobile computing product line, designing software for retrieving context-information from mobile and intermittently connected devices and for intelligently routing messages to appropriate pervasive terminals. As part of this work, his group is exploring the use of SIP for retrieving an individual's activity on different communication channels and thereby enhanching presence to reflect an individual's availability for various tasks. As part of his earlier job as a researcher at Telcordia Technologies (Bellcore), Archan worked on mobility management architectures for IP-based cellular networks, including both network-layer (extensions to Mobile IP) and application-layer (extensions to SIP) handoff techniques. At present, Archan is also involved on behalf of IBM Research in the NSF-funded ORBIT project, in particular for building MAC-layer techniques (reliable multicasting, pipelined forwarding etc.) that allow applications such as VoIP and SIP-based conferencing to operate efficiently in wireless mesh networks.

His other ongoing research efforts and interests include mobility protocols for next-generation (4G) wireless networks, protocols for high-performance wireless meshes and query middleware for wireless sensor networks. He has published extensively in the areas of wireless networking, congestion control and mobility management and was a co-author on papers that received the Best Paper awards in ACM WOWMOM 2002 and IEEE MILCOM 2001. He serves on the technical program committees of several conferences, such as IEEE INFOCOM and IEEE WOWMOM and is currently the Untethered Technologies chair of the IEEE Computer Society's Technical Committee on Computer Communications (TCCC). Archan received his Ph.D. in Electrical and Computer Engineering from the University of Maryland at College Park in May, 2000, and his B.Tech in Electronics and Communication Engineering from IIT Kharagpur, India in July 1993. Professional details are available at http://www.research.ibm.com/people/a/archan.

Avshalom Houri is an architect that specializes in SIP standards and architecture. Currently, Avshalom is working in IBM as a SIP standards expert and as SIP architect to the SIP infrastructure of IBM's Lotus Workplace™. He is a regular participant in the IETF since 1997 and is concentrating in the activities of SIP related groups in the IETF. He is working in IBM since 1996 and was one of the main architects that have designed the IBM Sametime™ servers. Prior to joining IBM he worked in Ubique™ that was one of the first Internet companies in Israel. Ubique was bought by America Oline and created Virtaul Places for them. After a while Ubique was spinned out from AOL and was bought by IBM. Avshalom received his Msc. in computer science from the Weizmann Institute in Rehovot Israel.