

Forwarding on Gates a Clean-Slate Replacement for IP

Florian Liers, Thomas Volkert

Research seminar – KIT Karlsruhe (February 2011)

Univ.-Prof. Dr.-Ing. habil. Andreas Mitschele-Thiel Integrated Communication Systems Group

17.02.2011

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- Main fields
 - Electrical engineering
 - Engineering
 - Computer science
 - Media
- Statistics
 - Professors: ~100
 - Students: ~6500



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3

ICS Group – Projects

- Integrated SW/HW Systems
 - ERADOS "Experimentelle Forschung zur adaptiven Fehlerdiagnose basierend auf strukturellen multi-core Emulationstest" (TAB)
 - Quadrocopter Lab
- Mobile communication
 - DFG Graduiertenkolleg "Self-organized Mobile Communication Systems for Disaster Scenarios"
 - Self-organization in LTE (ALU)
 - Cognitive Radio Network Lab (CZ Foundation)
 - MoSaKa "Mobile Satellitenkommunikation im Ka-Band" (BMWi)
 - G-Lab Forwarding on Gates (BMBF)

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Content

- Introduction
 - Problems
 - Design goals
 - Idea
- FoG
 - Gates and forwarding nodes
 - Architecture
 - Transfer service
 - Routing service & process internals
- Example routing service
 - Zone-based
- Summary

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Internet Problem 1: Naming

- DNS is just an add-on
- No split: name ⇔ address
- No application names



• IP address \neq location hint





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Internet Problem 2: QoS

- Assumption
 - FI requires QoS
- Main problems for inter-network
 - Location of state information?
 - -AAA?
 - Provider policies?
- Dependencies
 - Routing
 - Functions

per auton. system ➔ ~4 times



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Internet Problem 3: Functions

- Adding functionality •
 - Partial deployment
- Management complexity •
- Function •
 - Selection
 - Composition
- Location
 - End nodes
 - Intermediate nodes
- Dependencies •
 - Routing
 - Naming



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Design Goals Inter-Network

- Unrestricted naming
 - Naming applications
 - Internally visible addresses
- Improve QoS for inter-networks
 - Flexible state distribution
 - Built-in authentication
 - AAA
- Flexible function injection
 - Dynamic function chaining
 - Simplify management



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Transition of Today's Stack

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13

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Forwarding in Stacks and Networks

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Gate ("Edge" Building Block)

Represent

- Abstraction of lower layer links
 - Unicast
 - Broadcast
 - Multicast
- Implementation of application functions
 - Video encoder/decoder
 - Data filter: virus scanner
 - Packet filter: firewall
- Additional attributes
 - Quality guarantees
- Sequentially combinable
 - Packets are transmitted gate by gate
- Recursively combinable
 - Can consist of gates and FN

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FoG Architecture

- Transfer service (TS)
 - Packet forwarding
 - Consists of and manages
 - Gates
 - Forwarding nodes
 - Manipulates packet headers
- Routing service (RS)
 - Path calculation
 - Supports partial routing
- Authentication service (AS)
 - AAA support
 - Based on PKI

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Transfer Service

- Manager •
 - Observes local topology
 - Policy handling
 - Error handling
 - Sends topology updates to RS
 - Uses AS for AAA
- Sockets ullet
 - Communication end point
 - Chain of gates
 - Supports data sending and receiving
- Transfer Plane •
 - Consists of gates and FNs
 - Informs manager about
 - Errors
 - Topology changes

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Higher Layer

Routing Service

- Requirements Mapping
 - Application requirements ⇔ gate types
 - Topology attributes ⇔ additional gate attributes
- Name Mapping
 - Support human readable names
 - Names ⇔ internal addresses
- Path Calculation
 - Triggers creation of additional gates in TS
- Graph Database
 - Stores information from TS
 - Reports topology

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Description Language

- For
 - application requirements
 - gates
 - gate types
- Idea
 - Object oriented
 - Extendable
 - Serializable (e.g. XML)
 - No negotiation process (just yes/no)
- (Ordered) set of
 - Non-functional properties
 - Bandwidth (min, max)
 - Delay (min, max)
 - Loss rate (max)
 - Ordering (boolean)
 - Functional properties
 - Ciphering
 - Error correction
 - Order
 - Virus check

Rule: >= Rule: + Rule: +(1-x)* Rule: &&

Gates "Encryption" and "Decryption" Gates "Checksum" and "Check" Gates "Numbering" and "Sort" Gate "Virus check"

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Assignment unclear

Routing Based on Policies

Message Structure

Incremental vs. Source Routing

• Better scalability

- Nodes with limited knowledge
- Iterative process
- Security
 - Policy-based routing
- Explicit admission control
 - Route access
 - QoS usage
- Independent from under laying network type
 - Wired & wireless networks

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Zone-based Routing Approach

- Routing hierarchy
 - Problem separation: Partial routing based on zones
 - One coordinator per zone
 - QoS support: traffic classification and separation
 - Hierarchical addressing: used to identify target zone
- Partial routing from S to D:

Zone-based Flexibility

- Hierarchy
 - Depth / cluster size → performance vs. management
 - Dynamic of clustering / forbidden merges
- Route calculation
 - Topology distribution protocol
 - Use BGP
 - Use OSPF
 - Network policy

 Iocation dependent routing behavior
- Coordinators
 - Nodes priority
 - Amount of failover instances

Summary

- Focused on inter-networks
- Forwarding
 - Based on building blocks
 - Universal for stack and network
- Routing
 - Incremental process
 - Supports QoS
 - Zone-based routing approach
 - Scalability and flexibility

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Benefits of FoG

- For providers/administrators
 - Unified management interface
 - Easy to add additional functions
 - Hide network structure
 - Routing and security policies
 - Explicit admission control
- For protocol/application developers
 - Flexible naming and routing
- For users
 - Requirements handling
 - QoS support

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Related Topics in SIG Funcomp

- Description language
 - Defining requirements & BBs?
 - Three use cases (Netlets, Sonate, FoG)
- Selection & Composition
 - How?
- API App ⇔ Network
 - One major issue for transition to FI!
 - Relation to recursive layers?
 - Independent of (inter-)network?
 - At least 5 examples (IP, Spovnet, Netlets, Sonate, FoG)

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