“Quick NAP” - Secure and Efficient Network Access Protocol

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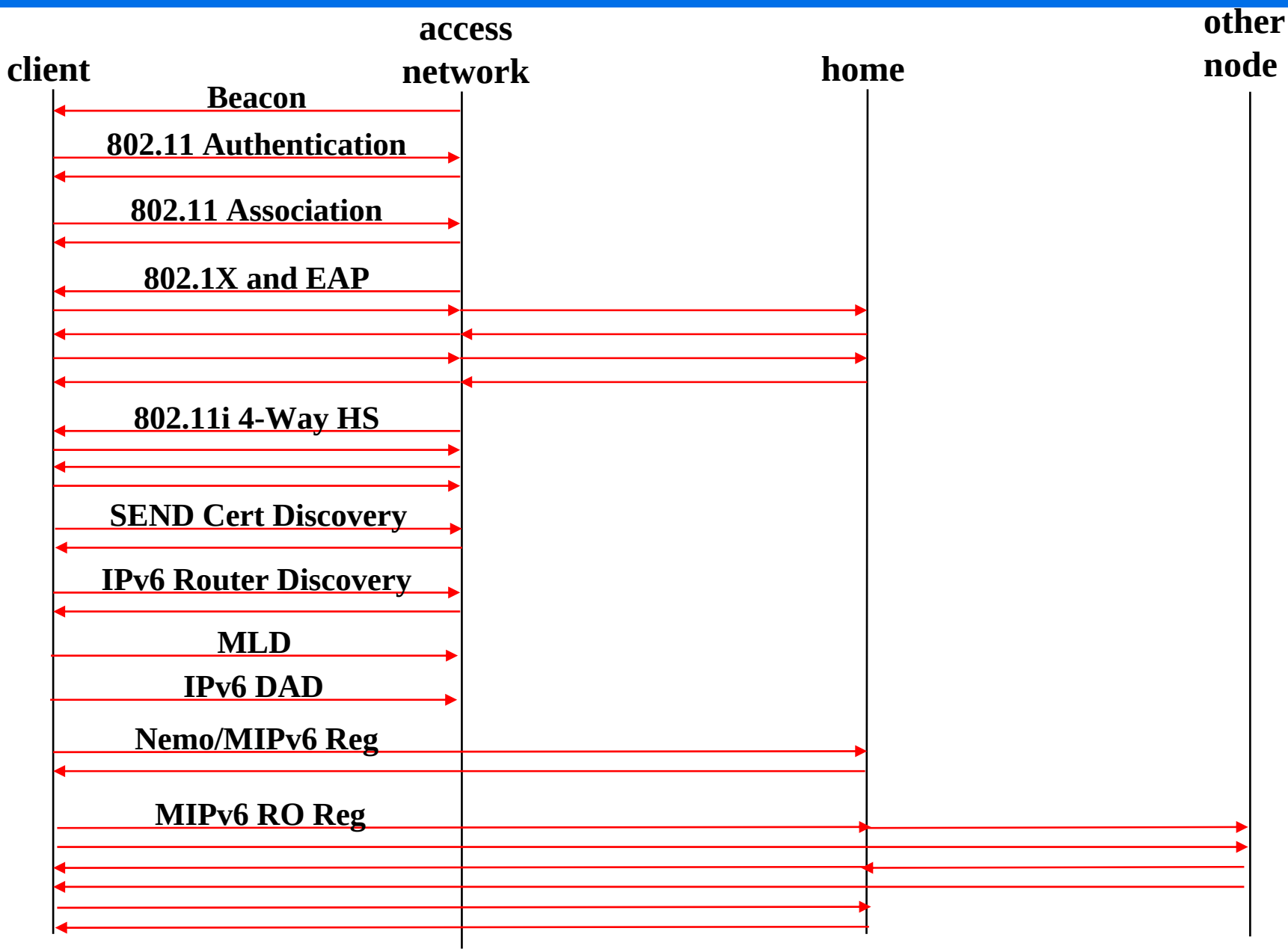
Presentation Outline

- The Problem
- Basis for a new design
- Tentative protocol proposal
- Evaluation and next steps

The Problem

Performance in Network Access (1/2)

- The attachment/movement performance of current protocol stacks is not all that great
- Attachments involve a large number of messages
- Over 50% of this is due to security
- Request/Response style, even across the Internet
- Multiple mandatory waiting periods
- New features lead to a worse situation?


client
access network
home
other node
Beacon
802.11 Authentication
802.11 Association
802.1X and EAP
802.11i 4-Way HS
SEND Cert Discovery
IPv6 Router Discovery
MLD
IPv6 DAD
Nemo/MIPv6 Reg
MIPv6 RO Reg

Performance in Network Access (2/2)

- Much of the excess baggage is due to developing everything in separate SDOs and groups
- L2 fast handoff mechanisms exist, but do not help in all scenarios
- People are developing optimizations to, I believe, all individual parts of the shown flow
  - Will this be sufficient or do we have to collapse several functions into the same mechanisms?

Security in Network Access (1/2)

- Many known specific problems (e.g. algorithms)
  - Solvable
- Privacy protection is non-existent or incomplete
  - MAC addresses
  - Most exchanges are in the clear
  - Limitations in identity privacy support in the protocols
- Denial-of-Service problems
  - Use of cryptographic keys very late in the process
  - Attacks that create/leave state to network side elements
  - Insecure lower-layer “detach” messages

Security in Network Access (2/2)

- No security at all for the open model
- No security for related functions
  - E..g, DHCP security is not deployed
  - No security for control of firewall functions or QoS
  - Secure Neighbor Discovery could be deployed, but attacks remain
  - Why? Deploying new security credentials for these would be extremely expensive
  - Barrier for deploying new functions (e.g. FMIP)

Functionality in Network Access

- Manual processes
  - Web-logins break applications and can't be handled automatically by software
- Configuration and discovery support
  - What are the IP parameters that I can get from this access point?
  - Is my home operator available via this access point?
- Security models do not fit all types of deployment
  - Credit card payments

Ongoing Work

Ongoing Work to Address the Problems...

There is ongoing work for most of the problems:

- IP mobility
  - Optimized mobility mechanisms, e.g., new faster signaling schemes for route optimization
- Address autoconfiguration
  - IPv6 addressing speedups, e.g., Optimistic DAD
  - DHCP and SEND security
- DNA
  - Faster algorithms for detecting whether or not movement has occurred

Ongoing Work, Continued

- Link layer
  - Pre-authentication and proactive key distribution
  - Better protection of payload packets (AES etc)
  - Better information channels from the network to the clients (e.g., 802.21)
  - Bigger subnets (less IP layer work after attachment)
  - ...

Ongoing work

- Everything on previous slides is being addressed
  - People care about this and there are a lot of results!
- Most work focused on a particular “slice” of the problem
- No good understanding of what the impact of individual improvement is for effiency
  - E.g., “I can’t afford 1 RTT in Mobile IP”
- Not enough system-level understanding of the security issues

Basis for a New Design

Approach

- Attempting to solve some of the security, functional, and performance issues
- Focus on the problem as a whole!
  - There are multiple parties involved -- not just two
  - Who needs to communicate with who?
  - How are the parties identified?
  - What is the optimal order of messages?
  - What system security properties are needed?
  - Are there bulk information transfer needs? How can they best be addressed?

Potential Solution Ingredients (1/3)

Security:

- Denial-of-Service protection
  - No separation to “attachment” and “secure attachment”
  - Stateless design on the network side
- Privacy protection
  - Build the protocols for non-static identifiers and addresses
  - Protect communications from the start, not at the end
- Uses hashes of public keys as addresses (a la CGA)
  - Avoid address stealing and functionality to bind addresses to credentials
  - Nodes can generate their addresses and keys on their own, without infrastructure -- works for ad hoc mode too!

Potential Solution Ingredients (2/3)

Protocol construction

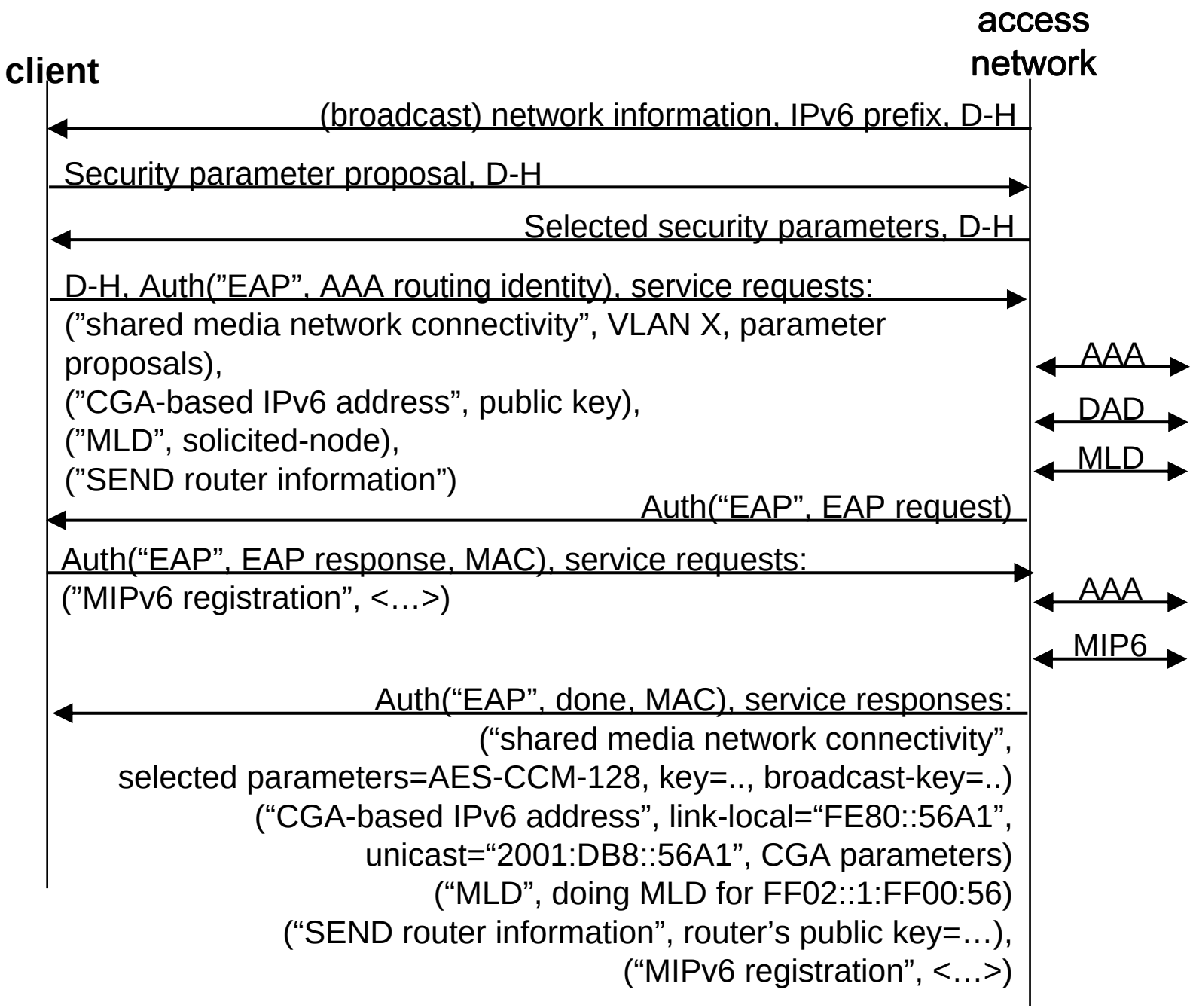
- Message order
  - Find out what information the whole problem involves, and how many messages need to carry it and re-think message order
  - Example: If the client's IP address was known earlier, the authentication process with the home network could handle mobility-related registrations as well
- Information transfer capabilities should not be restricted to the initial authentication exchange

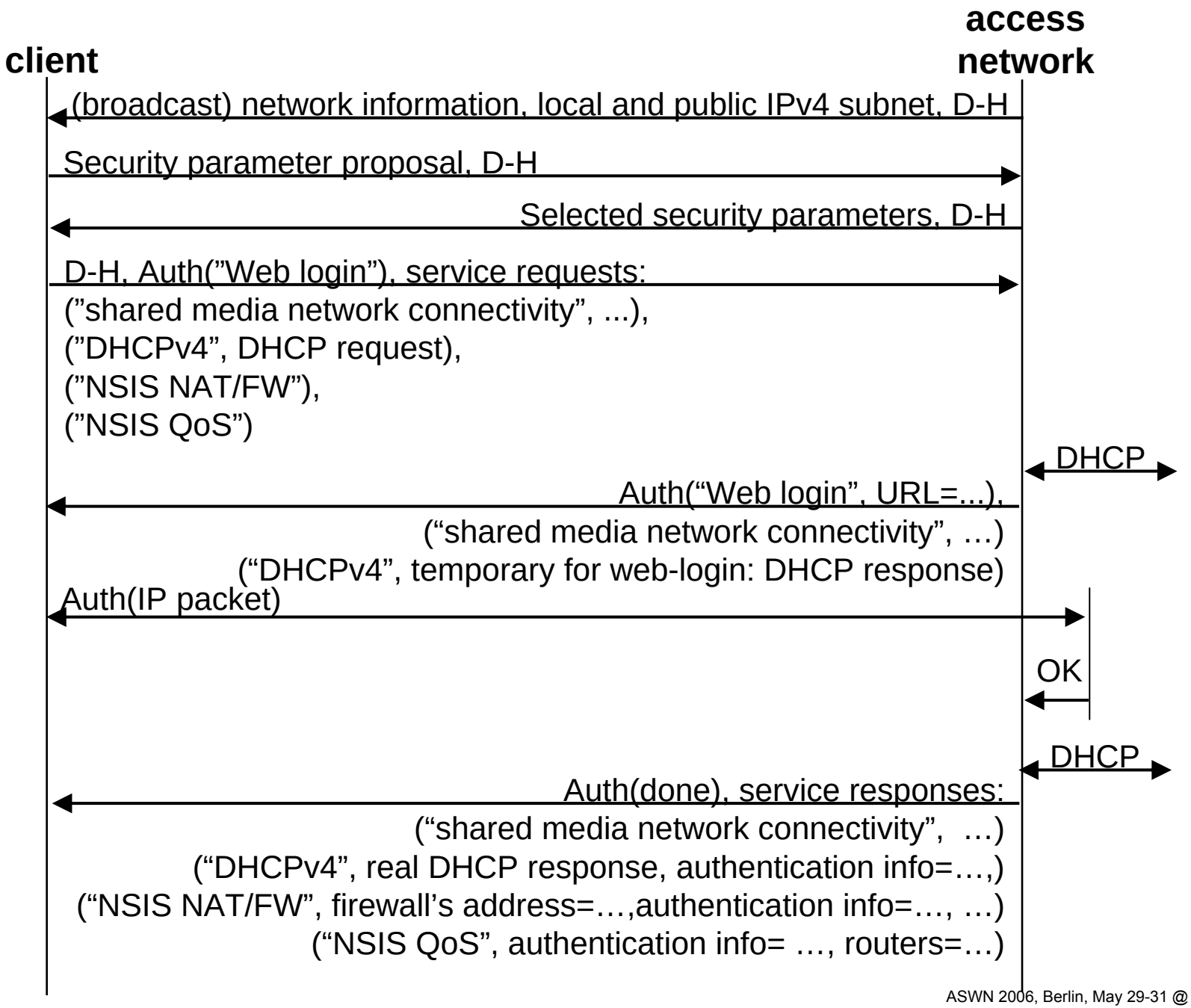
Potential Solution Ingredients (3/3)

Miscellaneous

- Delegation
  - Does the client have to be involved in tasks?
  - Can some tasks be delegated to the access point/router?
  - For instance, router based address assignment and DAD
  - Even a mobility related registration could be delegated

Tentative Protocol Design


client
access network
(broadcast) network information, IPv6 prefix, D-H
Security parameter proposal, D-H
Selected security parameters, D-H
D-H, Auth(”EAP”, AAA routing identity), service requests:
(”shared media network connectivity”, VLAN X, parameter proposals),
(”CGA-based IPv6 address”, public key),
(”MLD”, solicited-node),
(”SEND router information”)
AAA
DAD
MLD
Auth(“EAP”, EAP request)
Auth(“EAP”, EAP response, MAC), service requests:
(”MIPv6 registration”, <…>)
AAA
MIP6
Auth(“EAP”, done, MAC), service responses:
(“shared media network connectivity”,
selected parameters=AES-CCM-128, key=.., broadcast-key=..)
(“CGA-based IPv6 address”, link-local=“FE80::56A1”,
unicast=“2001:DB8::56A1”, CGA parameters)
(“MLD”, doing MLD for FF02::1:FF00:56)
(“SEND router information”, router’s public key=…),
(“MIPv6 registration”, <…>)


client
access network
(broadcast) network information, local and public IPv4 subnet, D-H
Security parameter proposal, D-H
Selected security parameters, D-H
D-H, Auth(”Web login”), service requests:
(”shared media network connectivity”, ...),
(”DHCPv4”, DHCP request),
(”NSIS NAT/FW”),
(”NSIS QoS”)
DHCP
Auth(“Web login”, URL=...),
(“shared media network connectivity”, …)
(“DHCPv4”, temporary for web-login: DHCP response)
Auth(IP packet)
OK
DHCP
Auth(done), service responses:
(“shared media network connectivity”, …)
(“DHCPv4”, real DHCP response, authentication info=…,)
(“NSIS NAT/FW”, firewall’s address=…,authentication info=…, …)
(“NSIS QoS”, authentication info= …, routers=…)

Evalution and Next Steps

Evaluation 1/2

- Significant reduction in number of messages
- No waiting periods
- Better privacy and DoS defense support
- Can be used to secure open models
- Can be used to secure other services (e.g. DHCP)
- Eliminates user intervention

Evaluation 2/2

- This may not be compatible with current protocols; likely possible only in new link layers
- Deployment needs new client - AP protocol set
  - But not AP - AAA set
  - And no new credentials
- Access devices become involved in layer 3 operations
  - But we note that this is optional
- Layer-purists might object to our views

Next Steps

- Prototyping this and variations in the Ambient Networks EU project
- Continuing with detailed protocol design
- Get measurements on benefits
- Get experience on implementation feasibility
- Feedback ideas to new link layer designs

Questions?