Status update on ANIMA WG

SACM WG IETF102

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Slides at github.com/toerless/presenations/slides-ietf111-sacm-eckert-anima…

Background

The Autonomic Networking Integrated Model and Approach (ANIMA) working group develops and maintains specifications and documentation for interoperable protocols and procedures for secure automated network management and control of professionally-managed (*) networks.

- ANIMA as a good fit of SACM goals and a good platform for further SACM work ?!
- After ANIMA was formed, we did consult with SACM for alignment guidance
- And then we went away into producing our charter round 1 RFC and only recently charter round 2.
- Now we felt it was a good time to cirble back to SACM updating on what we didand encourage further collaboration / input from SACM community

(*) ANIMA does not want to step on HOMENET

From NMRG to ANIMA

NMRG Autonomic Networks:

Self-X networks. X = configuring, healing, managing, optimizing, protecting, ….
RFC7575/RFC7576

Network wide **Intent** based management

ASA – Autonomic Service Agents.

Distributed software modules embodying a decentralized or distributed function/service on network devics.

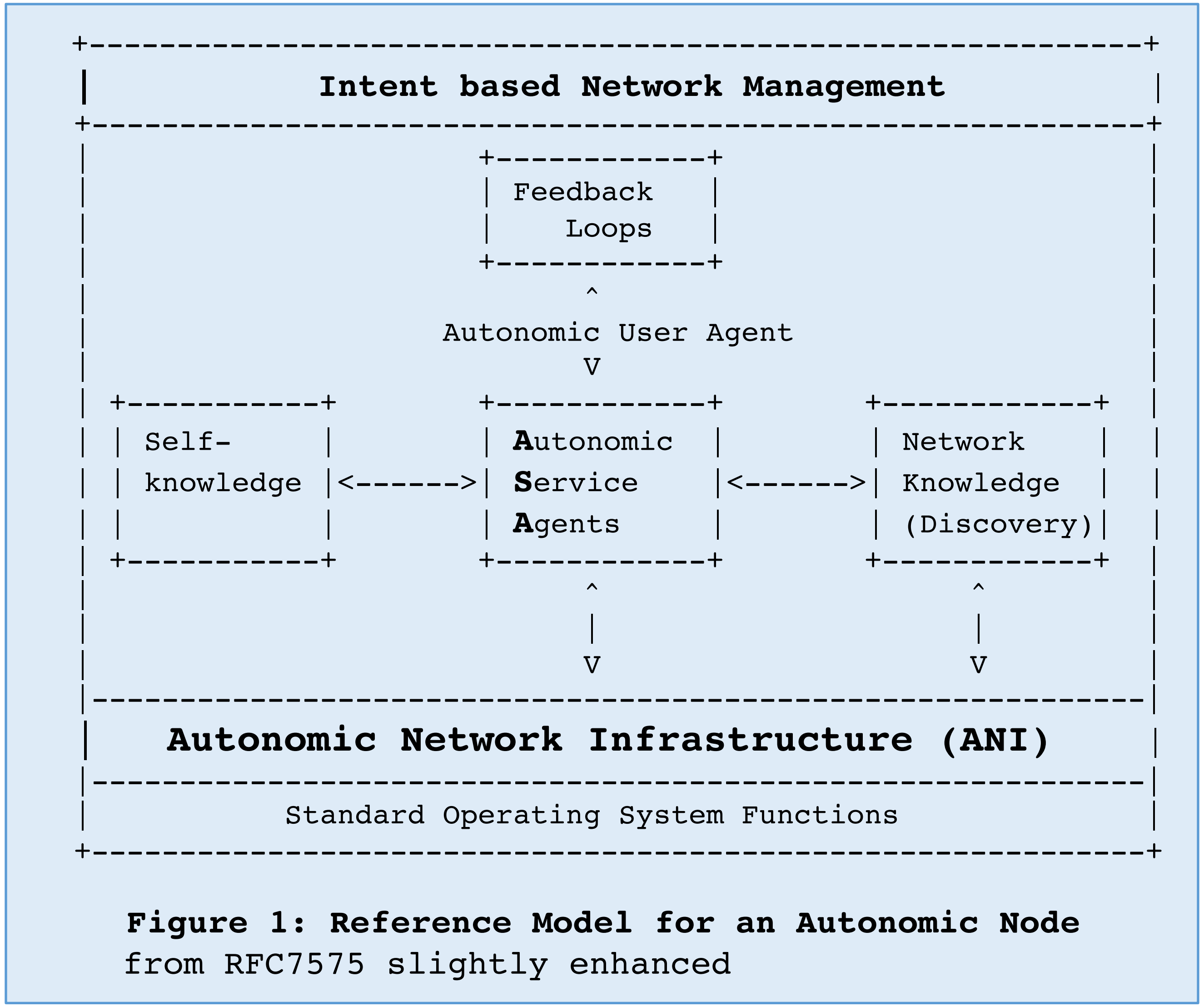
ANI - Autonomic **N**etwork **I**nfrastructure

Common infra for ASA and secure automation of legacy networks

BRKI: Secure, zero-touch bootstrap/onboarding

ACP: Secure zero-touch network wide connectivity

GRASP: Secure zero-touch extensible signaling



```
+---------------------------------------------------------+
|             Intent based Network Management              |
+---------------------------------------------------------+
|                      +------------+                      |
|                      | Feedback   |                      |
|                      |    Loops   |                      |
|                      +------------+                      |
|                            ^                             |
|                   Autonomic User Agent                   |
|                            V                             |
| +-----------+         +------------+         +------------+ |
| | Self-     |         | Autonomic  |         | Network    | |
| | knowledge |<------->| Service    |<------->| Knowledge  | |
| |           |         | Agents     |         | (Discovery)| |
| +-----------+         +------------+         +------------+ |
|                            ^                      ^       |
|                            |                      |       |
|                            V                      V       |
|---------------------------------------------------------|
|        Autonomic Network Infrastructure (ANI)            |
|---------------------------------------------------------|
|             Standard Operating System Functions          |
+---------------------------------------------------------+
```

Figure 1: Reference Model for an Autonomic Node
from RFC7575 slightly enhanced

ANIMA Charter round 1 (ANI) published

Autonomic Neworking Infrastructure (ANI)

May 2021 RFC-Editor Cluster 325, 420 pages

RFC8366: Validation use case 1: Stable Connectivity (23 pages)

RFC8368: BRSKI voucher (24 pages)

RFC8990: GRASP – Generic Autonomic Signaling Protocol (55 pages)

RFC8991: GRASP API (29 pages)

RFC8992: Validation use case 2: Prefix Management (19 pages)

RFC8993: Autonomic Networking Reference Model (26 pages)

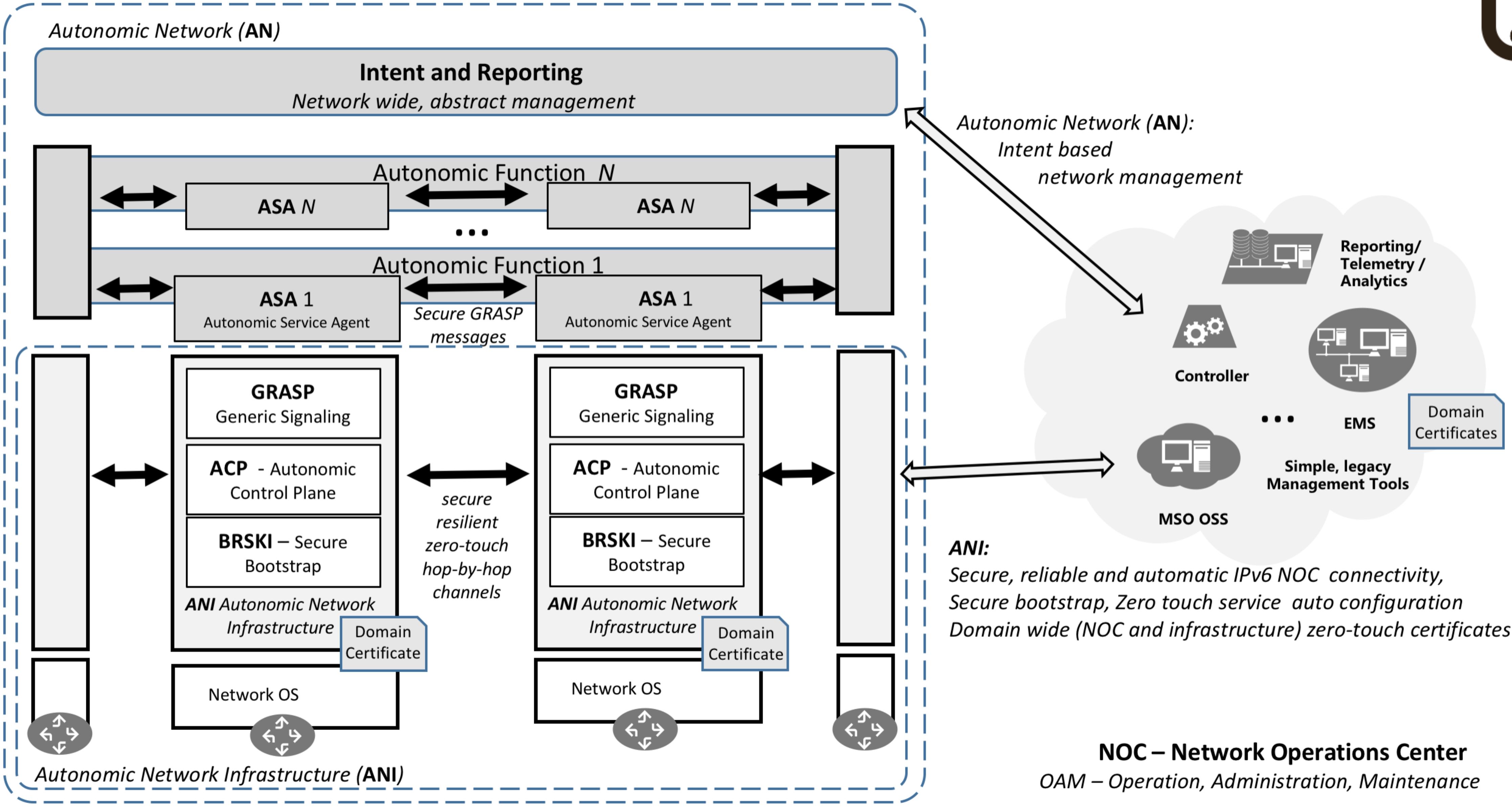
RFC8994: ACP – Autonomic Control Plane (128 pages)

RFC8995: BRSKI – Bootstrap Remote Key Infrastructures (116 pages)

Fig.1: Use-case example,
Autonomous opening of champagne bottle

For Self Study: Autonomic Network according to ANIMA RFC8993

GEEKOMETER



*Autonomic Network (**AN**)*

Intent and Reporting

Network wide, abstract management

Autonomic Function *N*

ASA *N*

ASA *N*

• • •

Autonomic Function 1

ASA 1

Autonomic Service Agent

Secure GRASP messages

ASA 1

Autonomic Service Agent

GRASP

Generic Signaling

ACP - Autonomic Control Plane

BRSKI – Secure Bootstrap

***ANI** Autonomic Network Infrastructure*

Domain Certificate

Network OS

secure resilient zero-touch hop-by-hop channels

GRASP

Generic Signaling

ACP - Autonomic Control Plane

BRSKI – Secure Bootstrap

***ANI** Autonomic Network Infrastructure*

Domain Certificate

Network OS

*Autonomic Network Infrastructure (**ANI**)*

*Autonomic Network (**AN**):*
Intent based
network management

Reporting/ Telemetry / Analytics

Controller

EMS

Domain Certificates

• • •

Simple, legacy Management Tools

MSO OSS

ANI:

Secure, reliable and automatic IPv6 NOC connectivity,
Secure bootstrap, Zero touch service auto configuration
Domain wide (NOC and infrastructure) zero-touch certificates

NOC – Network Operations Center

OAM – Operation, Administration, Maintenance

ANI operater experience

Day 1: Wide area network physically plugged together, connected to NOC, no CLI configured on any router, controller/orchestrator did nothing.

ANI/BRSKI gave all devices automatically X.509 ANI domain certificates

ANI/ACP automatically establishes on every link a secure ACP tunnel and on ever node a VRF with network wide IPv6 connectivity ONLY for OAM by ASA or legacy NOC equipment, not for user traffic (in-band virtual network)

ANI/GRASP running across ANI/ACP provides service discovery for existing decentralized services e.g.: in NOC and common new signaling for ASA

No user packets will flow (nothing was configured). Unauthorized equipment can not connect, Attackers can not even eavesdrop ACP traffic on any link.

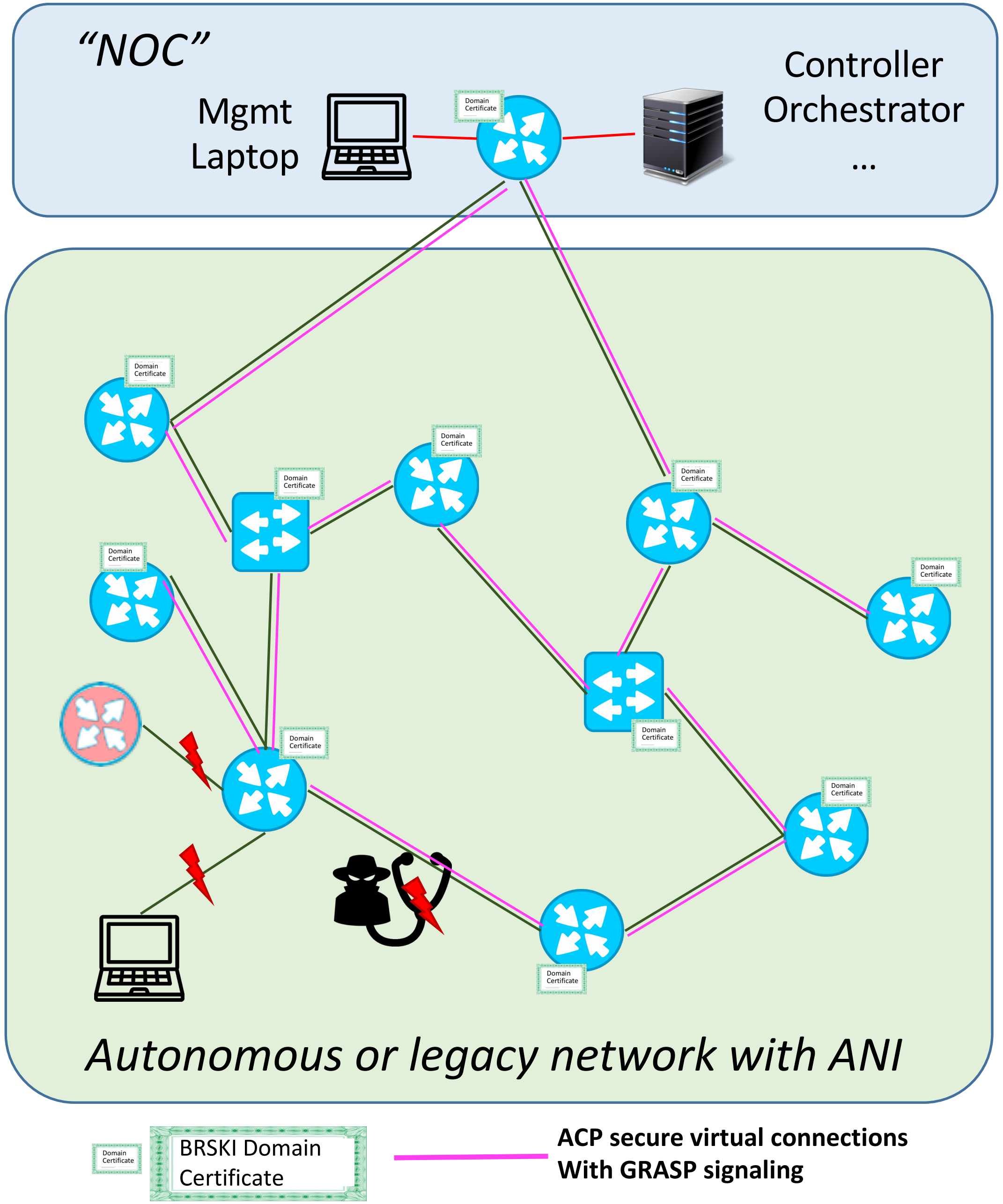
Manual / SDN / ASA provisioning/startup of config/services can commence

Day 1…N: Secure, Stable connectivity: Operator/Controller can configure any ANI device without out-of-band network. Misconfiguration of addressing, routing, security or other features can not disconnect NOC from ANI nodes, because ANI/ACP is not configurable (autonomous)

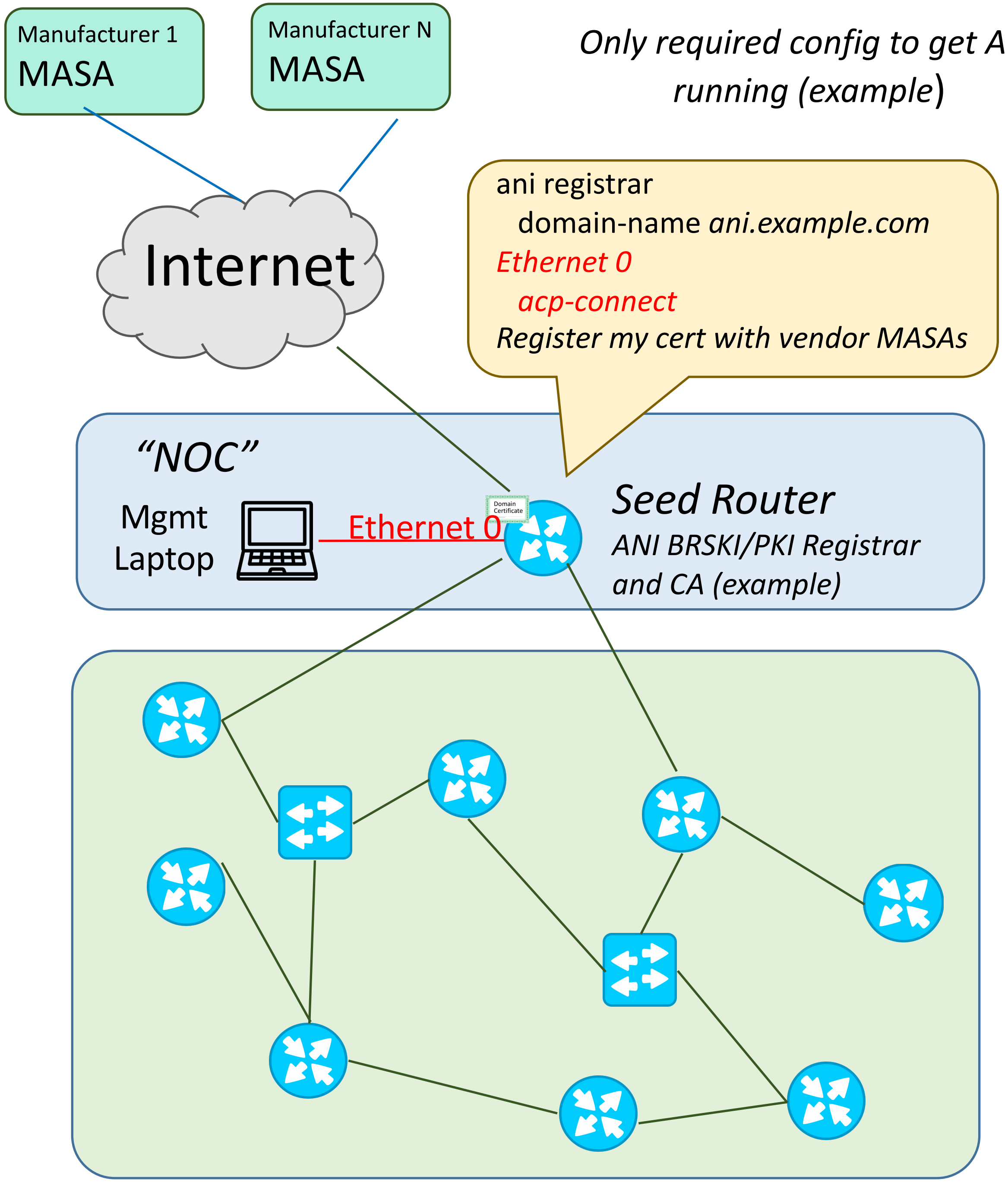
ACP will automatically adjust to new/failed links/nodes (ACP RPL routing protocol).

BRSKI/EST will automatically renew domain certificates

New ANI nodes can be added any time, impaired nodes can be revoked from ACP via their certificates.


"NOC"
Mgmt Laptop
Controller Orchestrator …
Domain Certificate
Autonomous or legacy network with ANI
Domain Certificate
BRSKI Domain Certificate
ACP secure virtual connections With GRASP signaling

How to bootstrap ANI



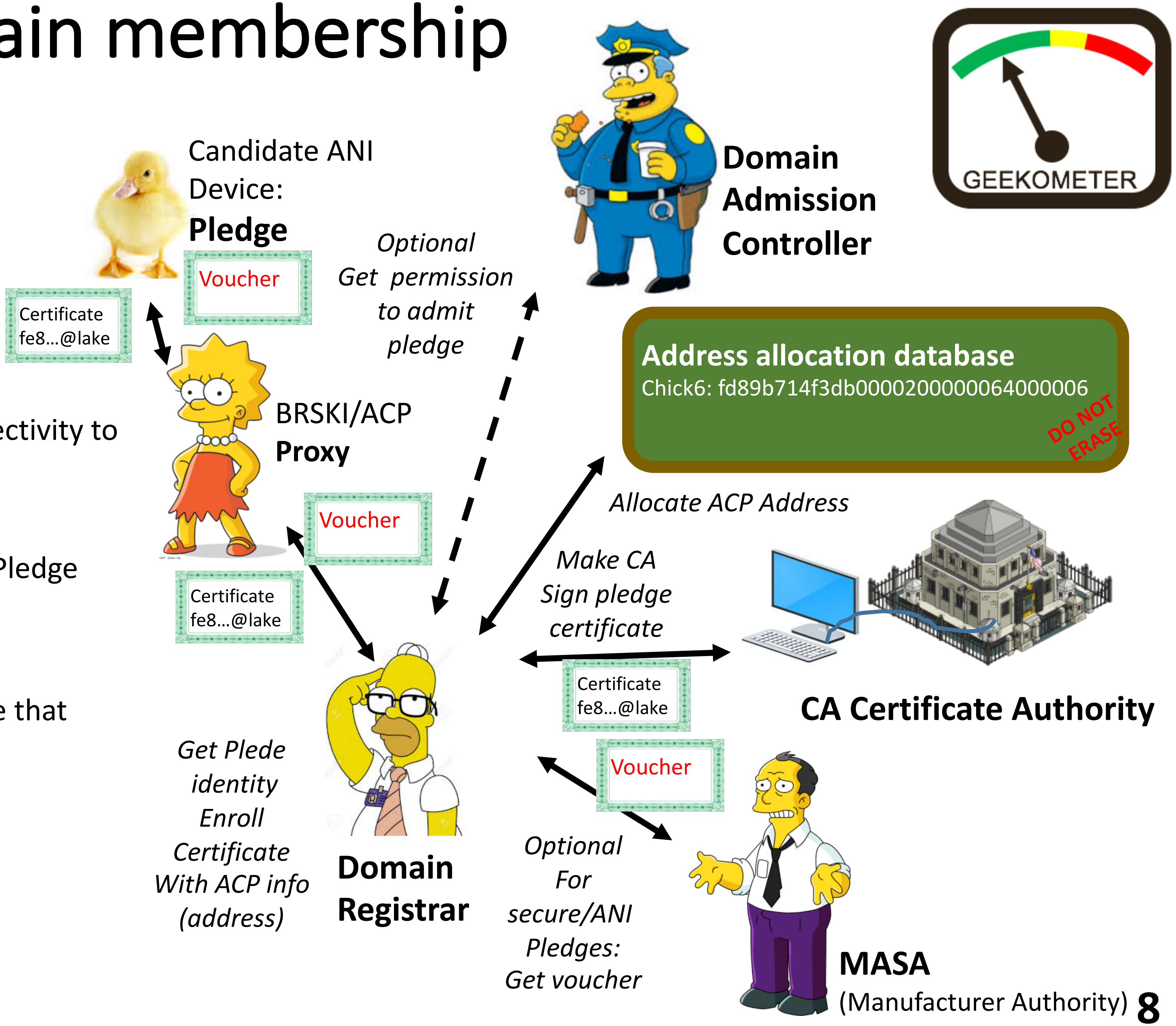
Only required config to get ANI running (example)

```
ani registrar
  domain-name ani.example.com
Ethernet 0
  acp-connect
Register my cert with vendor MASAs
```

Bootstrap to ANI domain membership

Eensemble cast, *not the script*

- Domain Registrar
  - Drives/coordinates process
- Pledge
  - The new, to-become domain member device
- Proxy
  - Distributed Agent to give registrar connectivity to adjacent pledge
- Manufacturer (MASA)
  - Authorizes Registrar towards Pledge so Pledge will permit to be enrolled into domain
- Voucher
  - New digital artefact to indicate to Pledge that Registrar is authorized to control Pledge
- Admission Control
- ACP Address allocation
- Certificate (signing)
  - Rely on certificate authority (CA) Potentially a hierarchy.



Candidate ANI Device:
Pledge

Voucher

Certificate
fe8…@lake

BRSKI/ACP
Proxy

Voucher

Certificate
fe8…@lake

Optional
Get permission
to admit
pledge

Domain
Admission
Controller

Address allocation database
Chick6: fd89b714f3db00002000000064000006
DO NOT ERASE

Allocate ACP Address

Make CA
Sign pledge
certificate

Certificate
fe8…@lake

CA Certificate Authority

Get Plede
identity
Enroll
Certificate
With ACP info
(address)

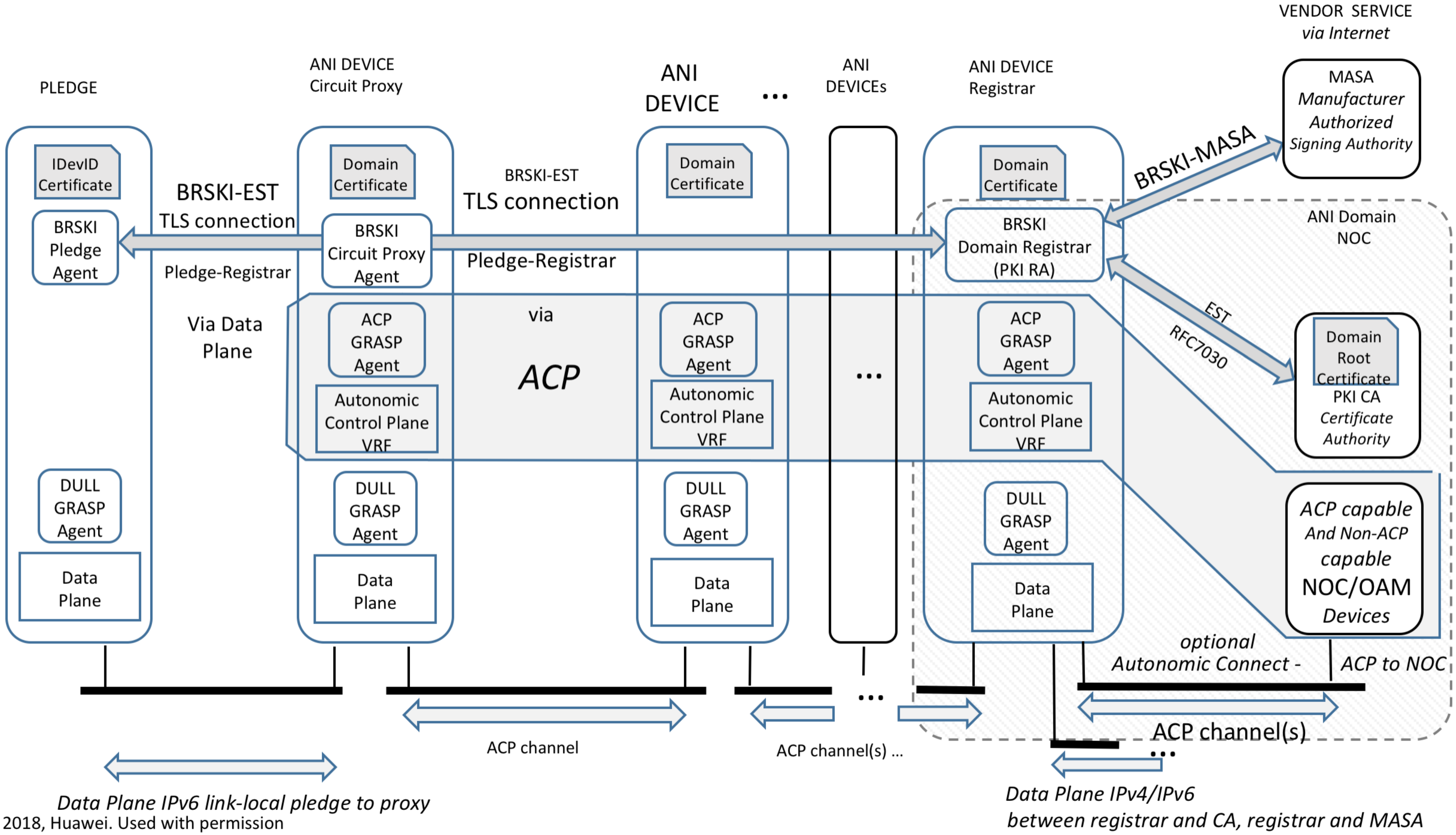
Domain
Registrar

Voucher

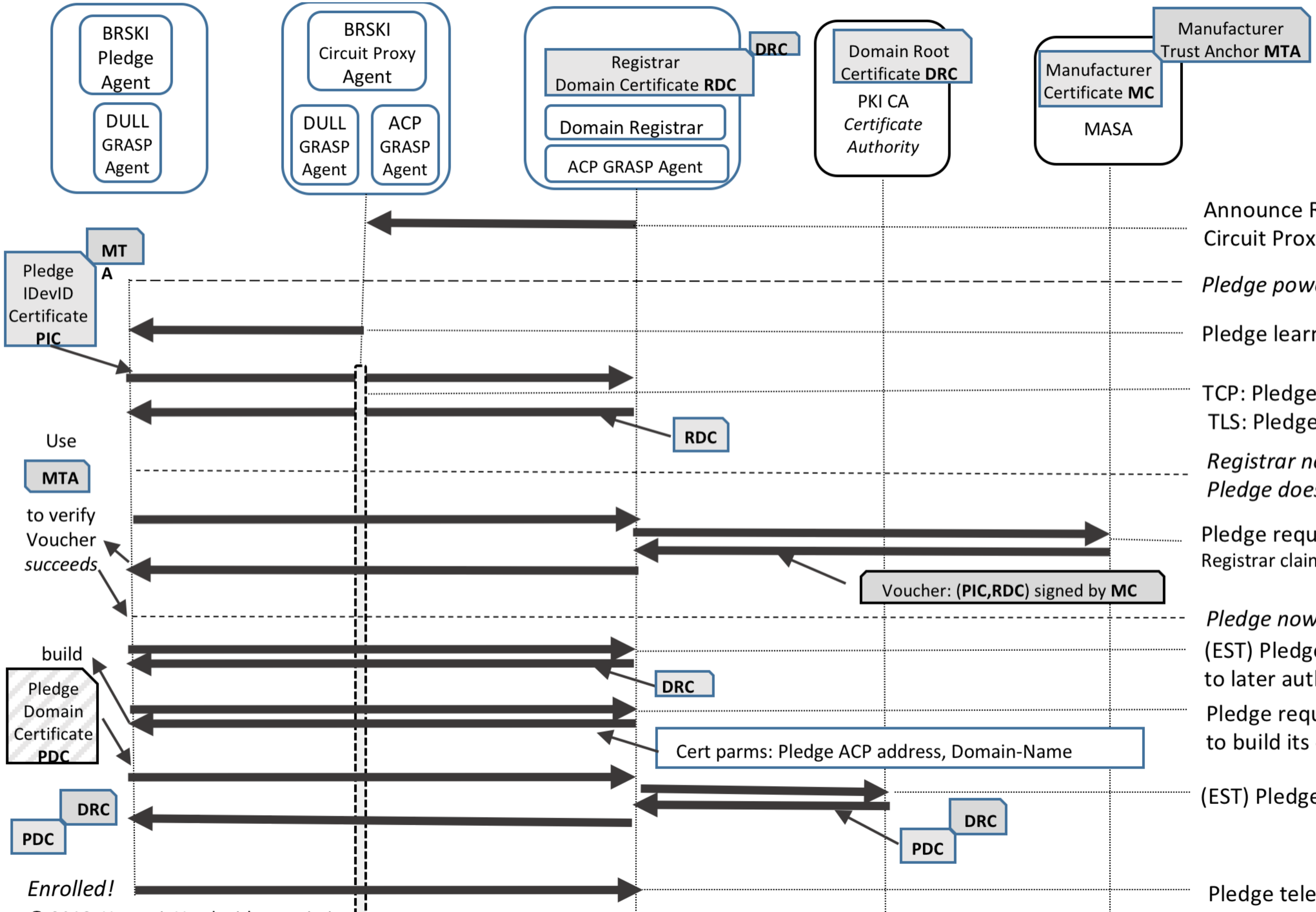
Optional
For
secure/ANI
Pledges:
Get voucher

MASA
(Manufacturer Authority)

For self-study: How does it really work – ANI (1)



For self-study: How does it really work - BRSKI (2)


BRSKI Pledge Agent
DULL GRASP Agent
BRSKI Circuit Proxy Agent
DULL GRASP Agent
ACP GRASP Agent
DRC
Registrar Domain Certificate **RDC**
Domain Registrar
ACP GRASP Agent
Domain Root Certificate **DRC**
PKI CA
Certificate Authority
Manufacturer Trust Anchor **MTA**
Manufacturer Certificate **MC**
MASA
MT
A
Pledge IDevID Certificate PIC
RDC
Use
MTA
to verify
Voucher
succeeds
Voucher: (**PIC,RDC**) signed by **MC**
build
Pledge Domain Certificate PDC
DRC
Cert parms: Pledge ACP address, Domain-Name
DRC
PDC
DRC
PDC
Enrolled!

Explanation

Signer

Certificate

Announce Registrar to all BRSKI Circuit Proxy agents via ACP GRASP

Pledge powers on / connects to Proxy

Pledge learns Proxy via DULL GRASP

TCP: Pledge <-> Proxy <-> Registrar
TLS: Pledge <-------------> Registrar (BRSKI)

Registrar now trusts PIC
Pledge does not yet trust RDC

Pledge request voucher to trust RDC
Registrar claim pledge to get voucher from MASA

Pledge now trusts RDC

(EST) Pledge requests trust anchor to later authenticate domain peers

Pledge requests cert parameters to build its domain certificate

(EST) Pledge requests signing of domain cert

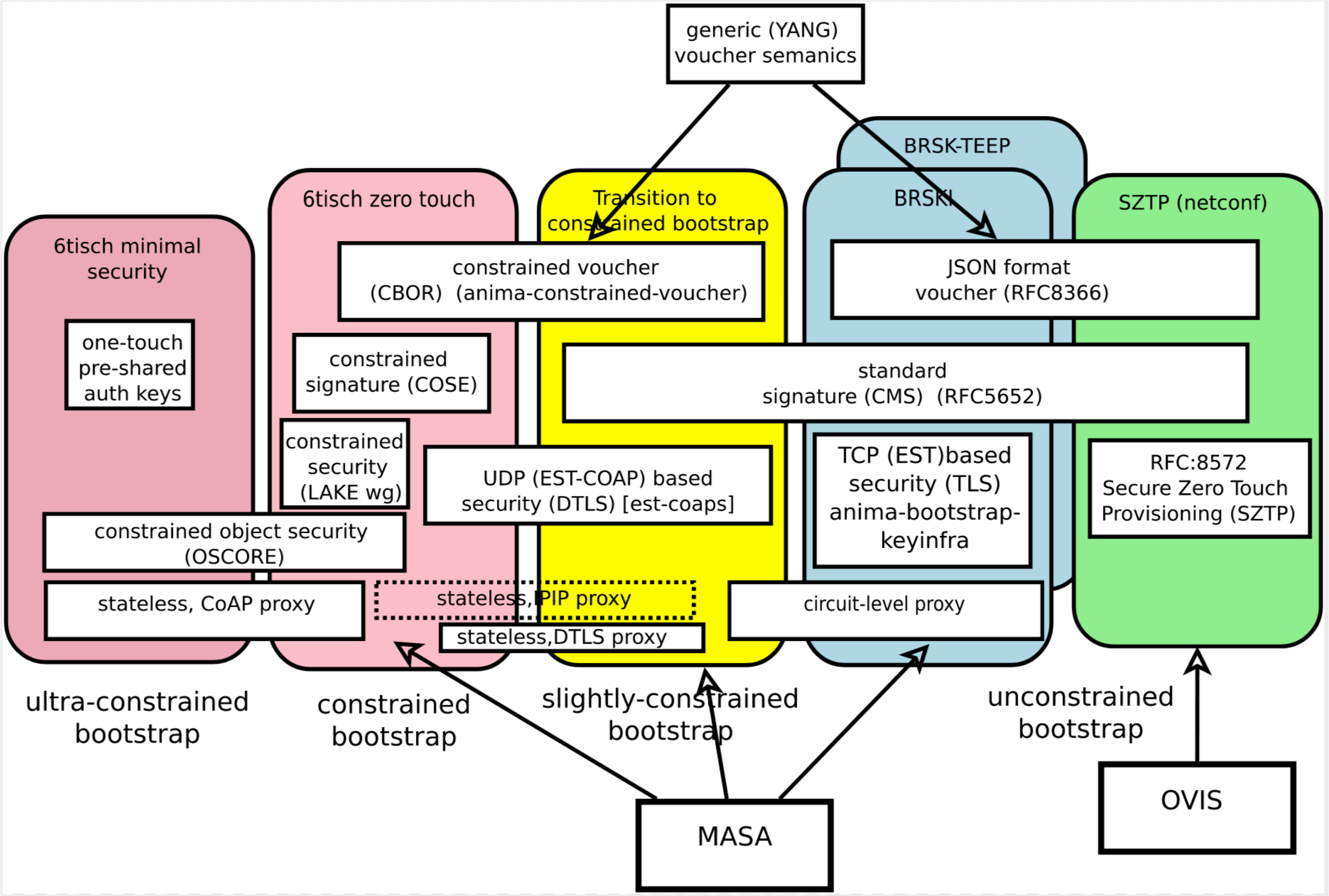
Pledge telemetry: I am enrolled!

Where are we now

- Since Q2’ 2020 on 2nd Charter
  - Added ASA work to charter
  - Added ANI enhancement
  - Pushed out Intent back to NMRG
    - NMRG nicely working on the research steps
  - But key ANIMA contributors busy with chater 1 until May.
- ANI: Bootstrap sees quite wide proliferation/adoption across IETF and industry (next slide)
  - Hackathon at IETF111, Also iot-onboarding / MUD adjacencies
  - Relatively little new code to write (on top of exising PKI, tool chains), but quite security critical
  - (Toerless) way too many different protocol preferences in different markets = many varitions needed.
  - Try to keep a common framework/common security behavior
  - Key work items: “constrained” devices BRSKI / voucher, cloud-connected registrar
- ANI: ACP seeing little movement yet
  - Logical ? Bootstrap must first work
  - Pre-standard industry implementations
  - (Toerless) Complex to implement well in legacy router infrastructures (much easier with newer/containerized/virtualized infrastructures, or BMC
- Various prototype implementations exist
  - More implementations welcome

Bootstrap landscape / roadmap

https://github.com/anima-wg/enrollment-roadmap (somewha stale)



What is next ? ASA ?!

Ongoing work in NMRG, then maybe ANIMA ?

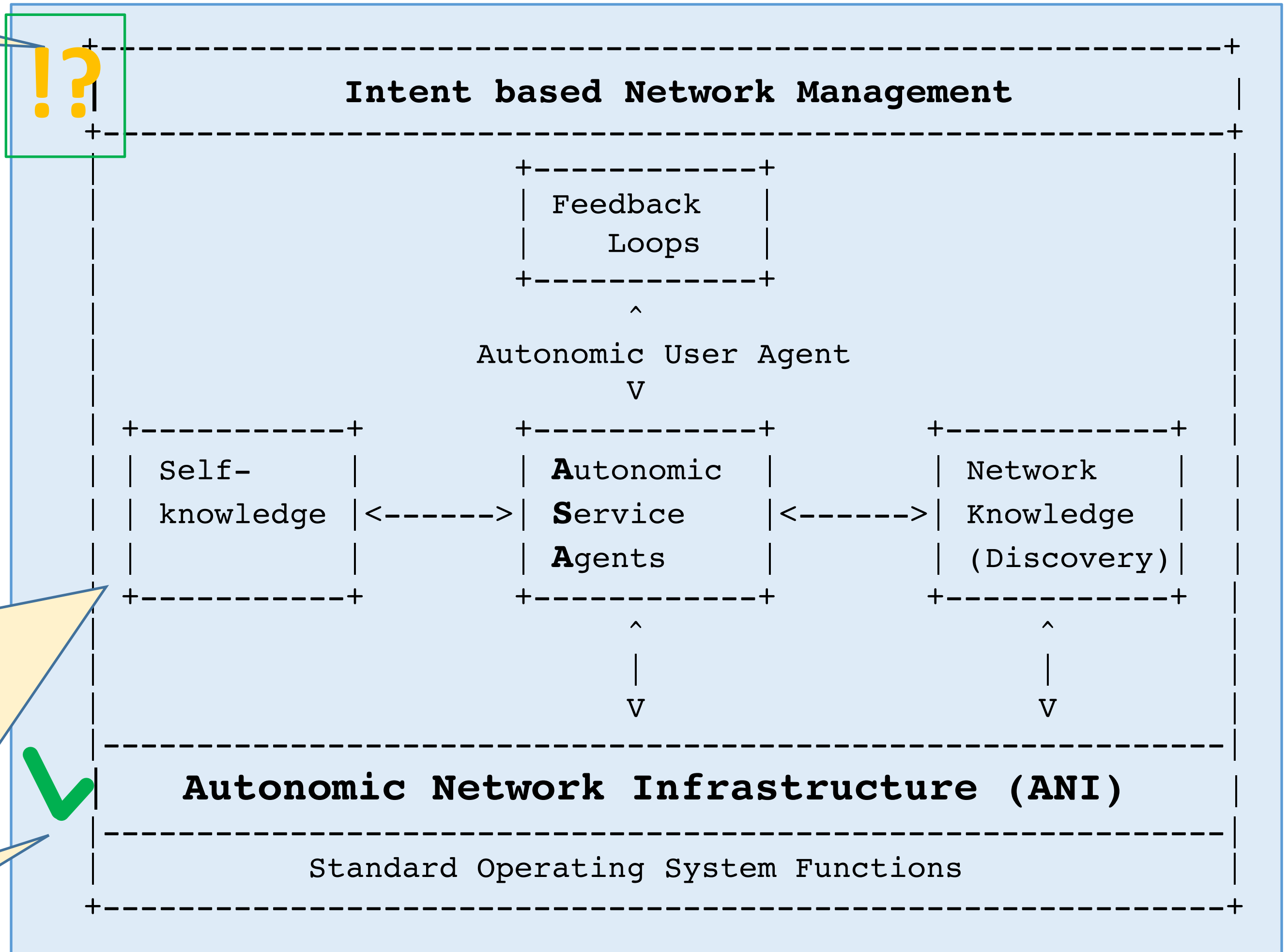
What distributed/decentralized services are of interest ?
especially also for security

We have seen many comprehensive, ambitious architectur proposals in ANIMA over the years

But ANIMA is in OPS, so we are primarily interested in stuff that can be operationalized (easily)

ANI with GRASP makes this easy and agile – including experimentation / prototyping

ANI and xtensions: Done/**ongoing in ANIMA** and especially bootstrap also in other groups



```
+-------------------------------------------------+
|        Intent based Network Management          |
+-------------------------------------------------+
|                 +-----------+                   |
|                 | Feedback  |                   |
|                 |    Loops  |                   |
|                 +-----------+                   |
|                      ^                          |
|              Autonomic User Agent               |
|                      V                          |
| +----------+     +------------+     +-----------+ |
| | Self-    |     | Autonomic  |     | Network   | |
| | knowledge|<--->| Service    |<--->| Knowledge | |
| |          |     | Agents     |     |(Discovery)| |
| +----------+     +------------+     +-----------+ |
|                      ^                   ^       |
|                      |                   |       |
|                      V                   V       |
|-------------------------------------------------|
|    Autonomic Network Infrastructure (ANI)       |
|-------------------------------------------------|
|        Standard Operating System Functions      |
+-------------------------------------------------+
```

Figure 1: Reference Model for an Autonomic Node
from RFC7575 slightly enhanced

Pragmatic considerations (1) (sorry, no eye candy)

- Application protocols with End-to-end encrypion (TLS, QUIC)
  - Do often not use strong, automatically renewed and flexible PKI certificates but just TLS with username/password and Web PKI with thir problematic Trust Anchor management.
  - Certificate management often seen as difficult by operators
- Just use ANI certificates ?!
  - Simply relying on ANI certificate could help to automate/use strong crypto for end-to-end applications
  - If existing ANI services are not sufficient, additional (higher layer) automation can be implemented as ASA
  - E.g.: additional role/authorization functionality for certificates via ANI/ASA so certificates become more functional

Pragmatic considerations (2) (sorry, no eye candy)

- Existing infrastructure services protocols are often not deployed with “security”
- Operationaly hard to do key management and bootstrap for the services.
  - NTP, DNS, SMTP, MacSec, routing protocols, “tftp”, IPFIX and several others
- When complely insecure protocols are run across ACP, their traffic is protected by ACP
  - Hop-by-hop authentication/encryption
- But many need their own, non-certificate credentials
  - And several should not run across ACP (OAM plane)
- ACP/GRASP ASA to the rescue
  - ASA does not need to worry about how to discover candidate protocol peers (link-local or ,network wide) whether to trust them, or how to come up with new messages – All done by ACP/GRASP
  - Simple to write distributed scripts (e.g.: TCL or pyhon) to automate generation and provisioning of such keying material
  - Automating e.g.: securing of routing protocols wih dynamic keys could be maybe a < 100 lines of code script using GRASP API (TBD)

If networks where cars

SDN-Controller

SDN-Orchestrator

SDN-Developer

Data Analyst

Network operator

Security Expert

In-network intelligence

→

ANIMA

"self driving networks"

The End

Please engage with us (proposal, questions, suggestion) if you think this is useful for you ! – anima@ietf.org