Versign DNSSEC Update

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DNSSEC at Verisign: Timeline

- *.edu*
  - Zone signed and DS record published in the root zone on **July 29, 2010**
  - (Verisign operates the registry for *.edu* under contract with EDUCAUSE.)
- *.net*
  - Zone signed and DS record published in the root zone on **December 9, 2010**
- *.com*
  - Signed now!
  - But unvalidatable (more on that in a moment)
  - On target for DS publication in the root on **March 31, 2011**

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Challenges for DNSSEC in *.com/.net/.edu*

- Sign and maintain a zone that is continually being updated
  - Tight service level agreements (SLAs) on interactions with ICANN-accredited registrars and DNS zone updates
- Safeguard cryptographic materials
- DNSSEC impact on resolution
  - Performance
  - Networking issues (fragmentation)
- Ensure valid DNSSEC responses

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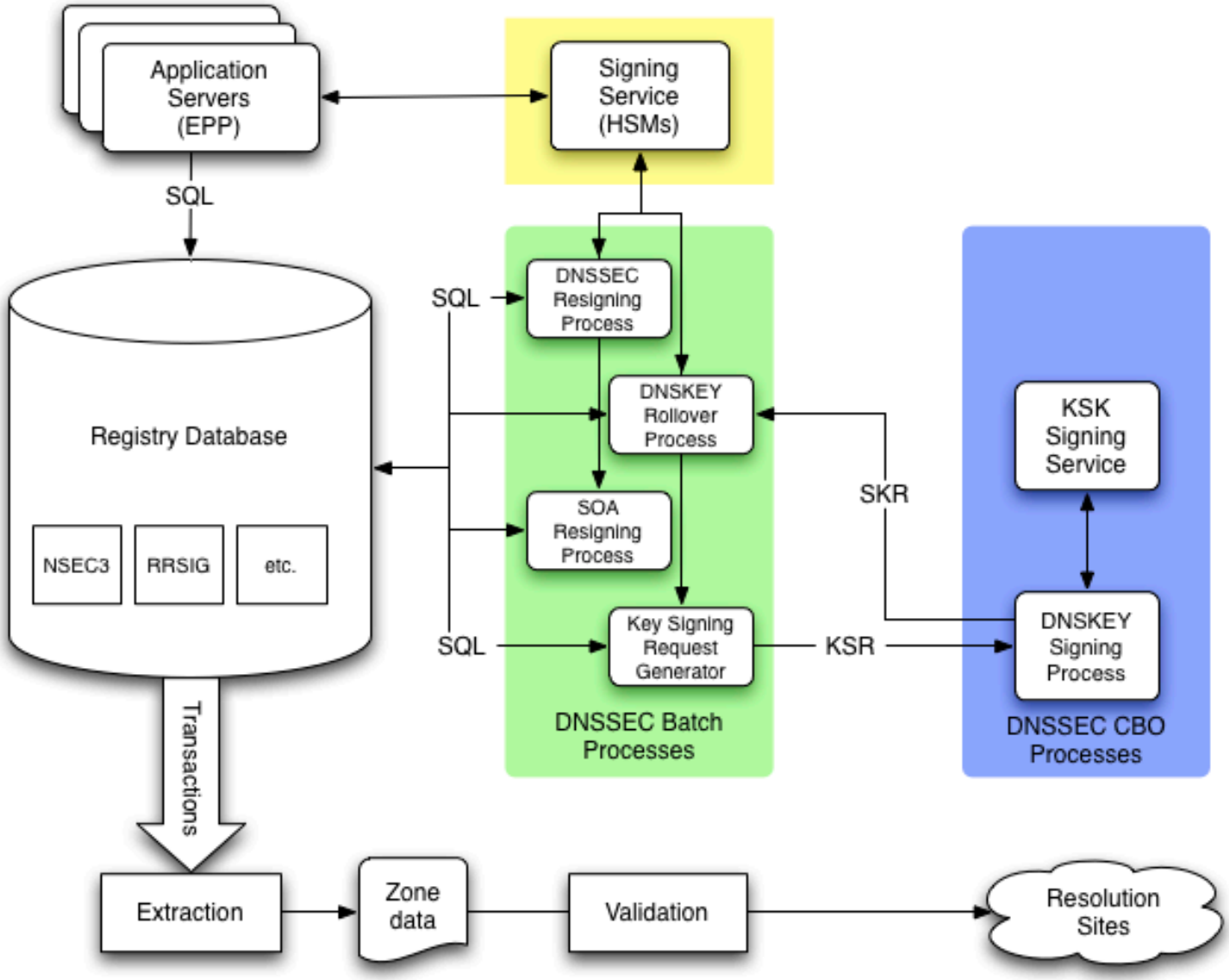
DNSSEC Provisioning: Architecture



DNSSEC Provisioning: New Features

- Changes to registrar interface
  - Extensible Provisioning Protocol (EPP)
  - Extended to allow DS records to be passed (RFC 5910)
- Sign changed zone data during EPP transaction
- Zone maintenance
  - Re-signing (signature refresh)
  - SOA serial number maintenance
  - Key rollover
    - KSK and ZSK

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DNSSEC Provisioning: Signing and Key Mgmt

- Signing Service
  - Abstracts multiple HSMs (Hardware Security Module)
  - Custom signing server software, high availability (HA)
- Key-signing Key (KSK) management
  - Cryptographic Business Operations (CBO) group
    - Handles key material
  - “Key Signing Request” (KSR)
    - Using technique and format from root signing project
    - Communicates zone-signing keys (ZSKs) to be signed
    - Concept similar to Certificate Signing Request (CSR) in X.509
    - Response is “Signed Key Response” (SKR) containing signatures made with KSK

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DNSSEC Provisioning: Need for a Signing Server

- Not practical to have an HSM for every app needing signing
  - Main servers, batch processes, admin tools, etc.
  - No HA/failover
- Need signing servers
- Benefits
  - Lower costs
  - Operational simplicity (keys, HSM management, number of components, etc.)
- Costs
  - Increased signing durations (network hops)
  - Development effort

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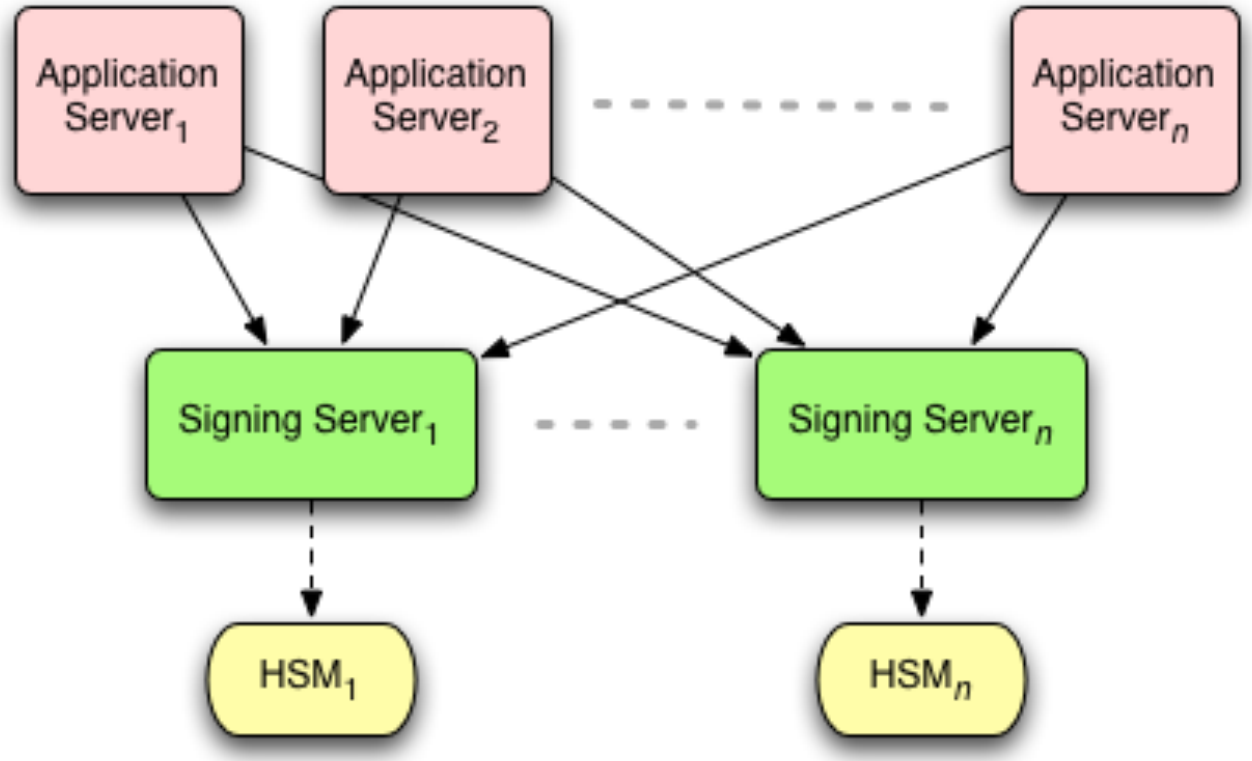
DNSSEC Provision: HSM HA Failover



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DNSSEC Provisioning: Key Management

- Collaboration with Cryptographic Business Operations (CBO) function
  - Specialize in HSMs and key management
  - Processes for security and auditing
- Provisioning of key-signing and zone-signing keys (KSKs, ZSKs)
  - KSKs kept offline
  - ZSKs loaded into HSMs and sent to provisioning data centers
- CBO pre-signs zone-apex DNSKEY data
  - Aforementioned KSR and SKR exchange

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DNSSEC Parameters for *.com / .net / .edu*

- 2048-bit KSK
  - Lifetime of years
  - No specific plans to roll
  - Will not use RFC 5011 rollover signaling protocol
- 1024-bit ZSK
  - Rolled every three months
- Signature durations
  - DNSKEY set (made with KSK): 7 days (2-day overlap)
  - All other zone data: 7 days (4-day overlap)
- RSA/SHA-256
- NSEC3 and Opt-Out
  - For reduced zone size, not confidentiality

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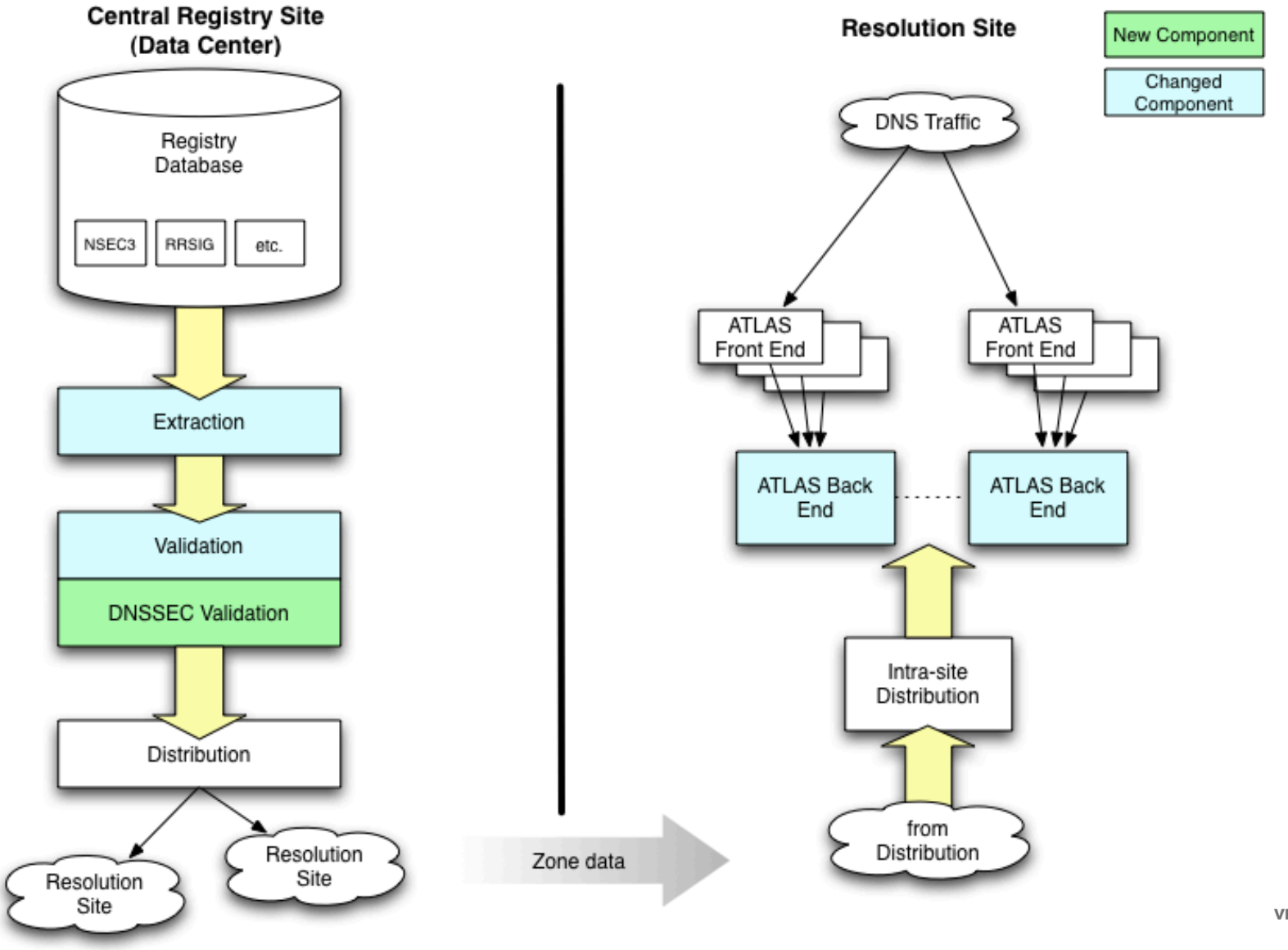
DNSSEC Resolution: Architecture



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DNSSEC Resolution: DNSSEC validation

- Must *never* publish data that does not validate
  - Bad data looks like attack!
  - *.com/.net/.edu* can never be wrong
  - Solution: Do semantic check in addition to existing integrity checks
- Methodology
  - Verify all signatures
  - Check for NSEC3s for all published DS RRs
  - Check NSEC3 chain
  - Etc.

DNSSEC Resolution: Network

- Fragmentation:
  - DNSSEC responses are “large”
  - DNS works much better over UDP
  - Large UDP responses may fragment
  - Current load balancer configurations don’t work with UDP fragments
- Fragmentation solutions:
  - Direct Server Return (DSR)
    - Scaling issues (ironically)
    - Operational concerns
  - Just Don’t Fragment
    - Truncate DNS responses that would fragment
    - May increase DNS TCP traffic
- Chosen solution:
  - Just Don’t Fragment
  - DNS responses kept below Ethernet 1500-byte MTU by truncation and “truncation”

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DNSSEC Deployment Approach

- Cautious and deliberate approach overall
- Deliberately unvalidatable zone
  - First used for root zone (DURZ)
  - Obscured key material to prevent validation
  - Still tests larger responses sizes and presence of DNSSEC metadata in responses

```
com.                IN DNSKEY 257 3 8 (
                       AwEAAa9Lp+++++++++++++++++THIS/IS/AN/INVALID/
                       KEY/AND/SHOULD/NOT/BE/USED/CONTACT/INFO/AT/V
                       ERISIGN+GRS/DOT/COM++++++++++++++++++++++++
                       ++++++++++++++++++++++++++++++++++++++++++++
                       ++++++++++++++++++++++++++++++++++++++++++++
                       ++++++++++++++++++++++++++++++++++++++++++++
                       ++++++++++++++++++++++++++++++++++++++++++++
                       ++++++++++++++++++++++++++++++++++++8=
                       ) ; key id = 30909
```

DNSSEC Deployment for *.com / .net / .edu*

- Resolution deployment steps (high level):
  - Slow rollout of DNSSEC-capable name server code to all resolution sites
  - Publish deliberately unvalidatable zone
  - Gradual rollout of signed zone, one site at a time
  - “Unblinding” of unvalidatable zone, one site at a time
  - DS records added to root zone
- Provisioning interface deployment steps (high level):
  - Operational Test & Evaluation (OT&E) environment for registrars
  - EPP DNSSEC extensions enabled in live registrar interface
- Always allow time at each step for “baking” and issues to be discovered or reported

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Issues Encountered During Deployment

- *.edu* zone
  - None reported
- *.net* zone
  - Bug in BIND 9.6.x and 9.7.0 affects DNSSEC validation when used as recursive name server
    - Resolution failures after DS for *.net* added to root zone
    - Name servers required restart
    - Have reported issue to BIND developers
    - Have publicized before *.com* signing
    - Apparent low impact (one report)

Lessons Learned

- **The Internet didn't break**

- Incremental deployment is possible (DURZ)
- Registrar test environment (with resolvable signed zone) helpful for every party (*.edu*)
- Monitoring is critical, especially surrounding key rollovers
- Issues with hardware and software installed base possible
  - BIND validation bug
  - Much hardware remains non-DNSSEC-capable
    - *http://verisigninc.com/assets/DataSheet-Verisign-InteropLab.pdf*

Best Practices

- Deliberately unvalidatable zone and slow rollout
- Strict key management practices
- Online ZSK / offline KSK (for expediency)
- Publish DNSSEC Practice Statement (DPS)
- Validate signed data before publishing

Work with ICANN-accredited Registrars

- Software Development Kit (SDK)
- Operational Test & Evaluation (OT&E) “sandbox” environment
- DNSSEC Resource Center
  - *http://verisigninc.com/en_US/why-verisign/innovation-initiatives/dnssec/index.xhtml*
- Tools guide
- Signing service

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Thank You

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