The Curious Case of the Crippling DS record

Public Safety Notice

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Overview

- Recent validation failures during KSK rollovers
- High level key rollover overview (double DS)
- When double DS fails
- What the standards say
- What do the DNSSEC Operational Practices say? (RFC6781)
- Notes on chains of trust
- What is this trying to prevent
- The missing advice

Recent validation failures during KSK rollovers

- Recently, a few top level domains were temporarily unresolvable.
  - There was no chain of trust
- Manually checking showed that there was a chain of trust:
  - There was a DS record, referring to a KSK, which in turn had signed the DNSKEY set.
- This happened when DS records were added
  - Which was part of a KSK rollover event.
- This failure was ”protocol compliant”
  - But completely unexpected.

High level key rollover overview (double DS)

- Reminder, always keep a chain of trust between parent and child:
  - DNSKEY is present in the child
  - DS record in parent contains a hash over a DNSKEY in child
  - DNSKEY signs the DNSKEY RRset in the child

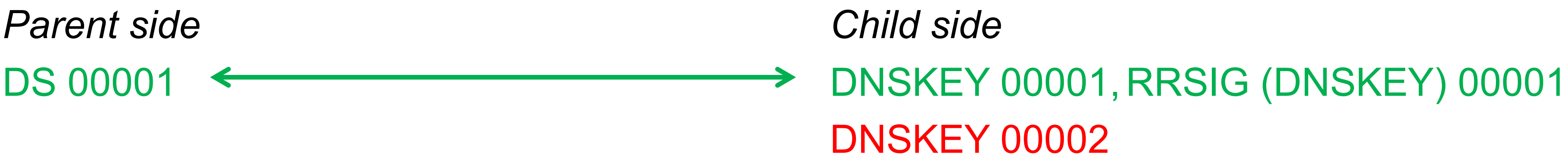
- No sudden moves:
  - Add new DNSKEY in child
  - Add DS record with hash over new DNSKEY in parent
  - Sign DNSKEY RRset with new DNSKEY instead of old DNSKEY

- Clean up:
  - Remove DS record in parent that contains a hash over old DNSKEY
  - Remove old DNSKEY from from child

High level key rollover overview (double DS)

Parent side		*Child side*
DS 00001	↔	DNSKEY 00001, RRSIG (DNSKEY) 00001

High level key rollover overview (double DS)



Parent side

DS 00001

Child side

DNSKEY 00001, RRSIG (DNSKEY) 00001

DNSKEY 00002

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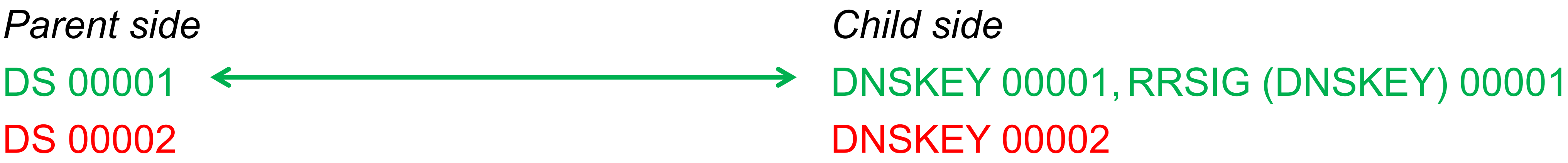


Parent side

DS 00001

DS 00002

Child side

DNSKEY 00001, RRSIG (DNSKEY) 00001

DNSKEY 00002

High level key rollover overview (double DS)

Parent side		*Child side*
DS 00001		DNSKEY 00001, ~~RRSIG (DNSKEY) 00001~~
DS 00002	↔	DNSKEY 00002, RRSIG (DNSKEY) 00002

High level key rollover overview (double DS)

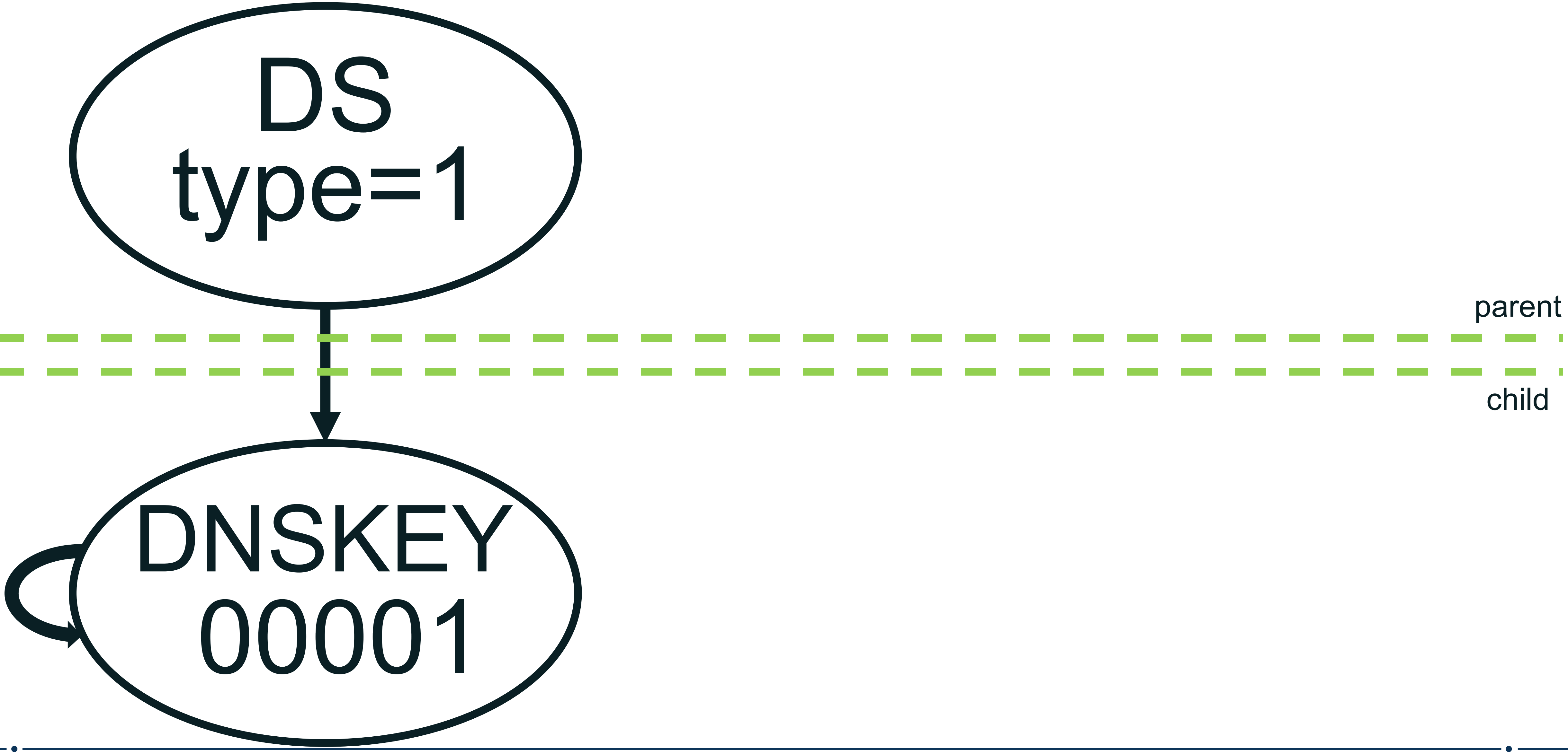
Parent side		*Child side*
~~DS 00001~~		~~DNSKEY 00001~~
DS 00002	↔	DNSKEY 00002, RRSIG (DNSKEY) 00002

High level key rollover overview (double DS)

Parent side *Child side*

DS 00002 ↔ DNSKEY 00002, RRSIG (DNSKEY) 00002

When double DS fails



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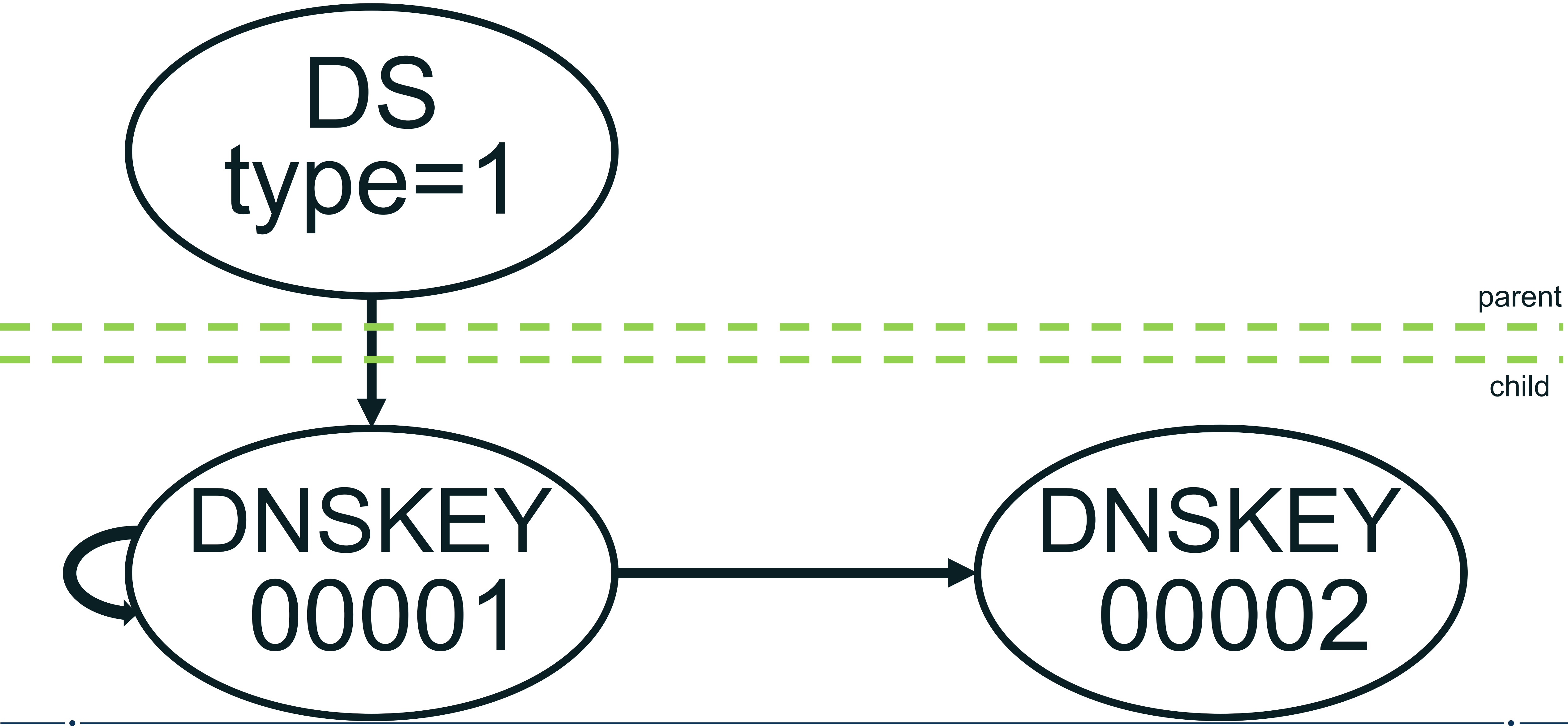

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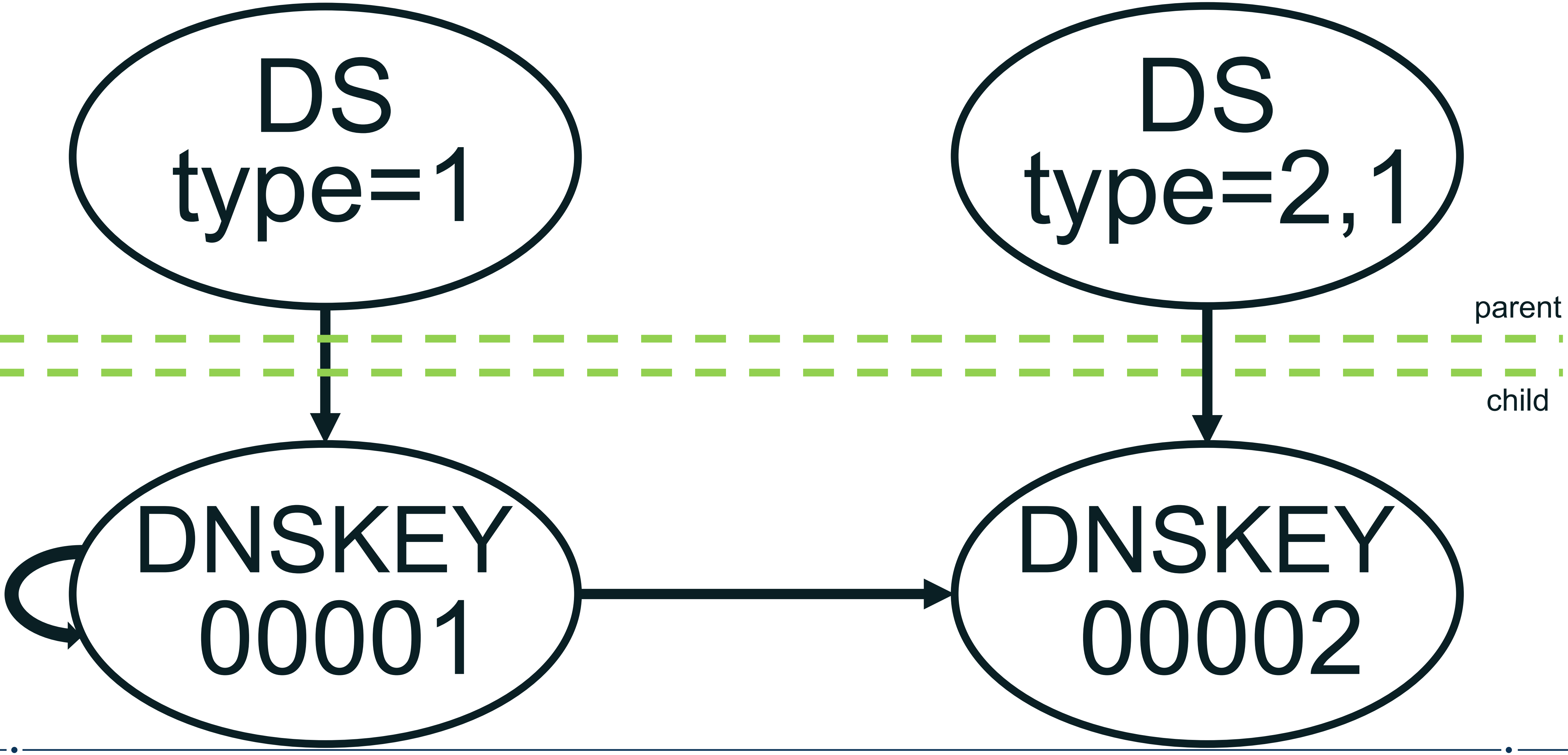

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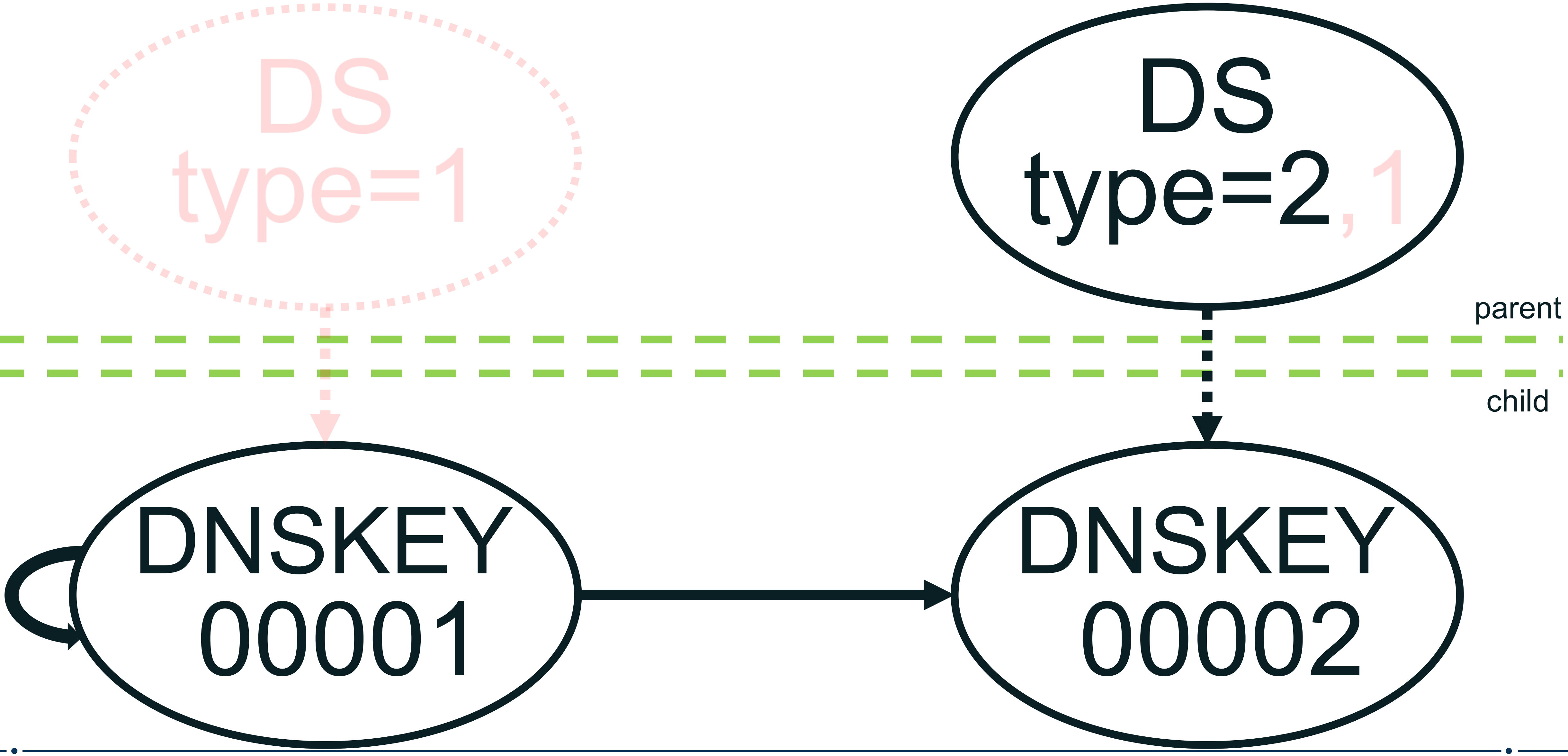

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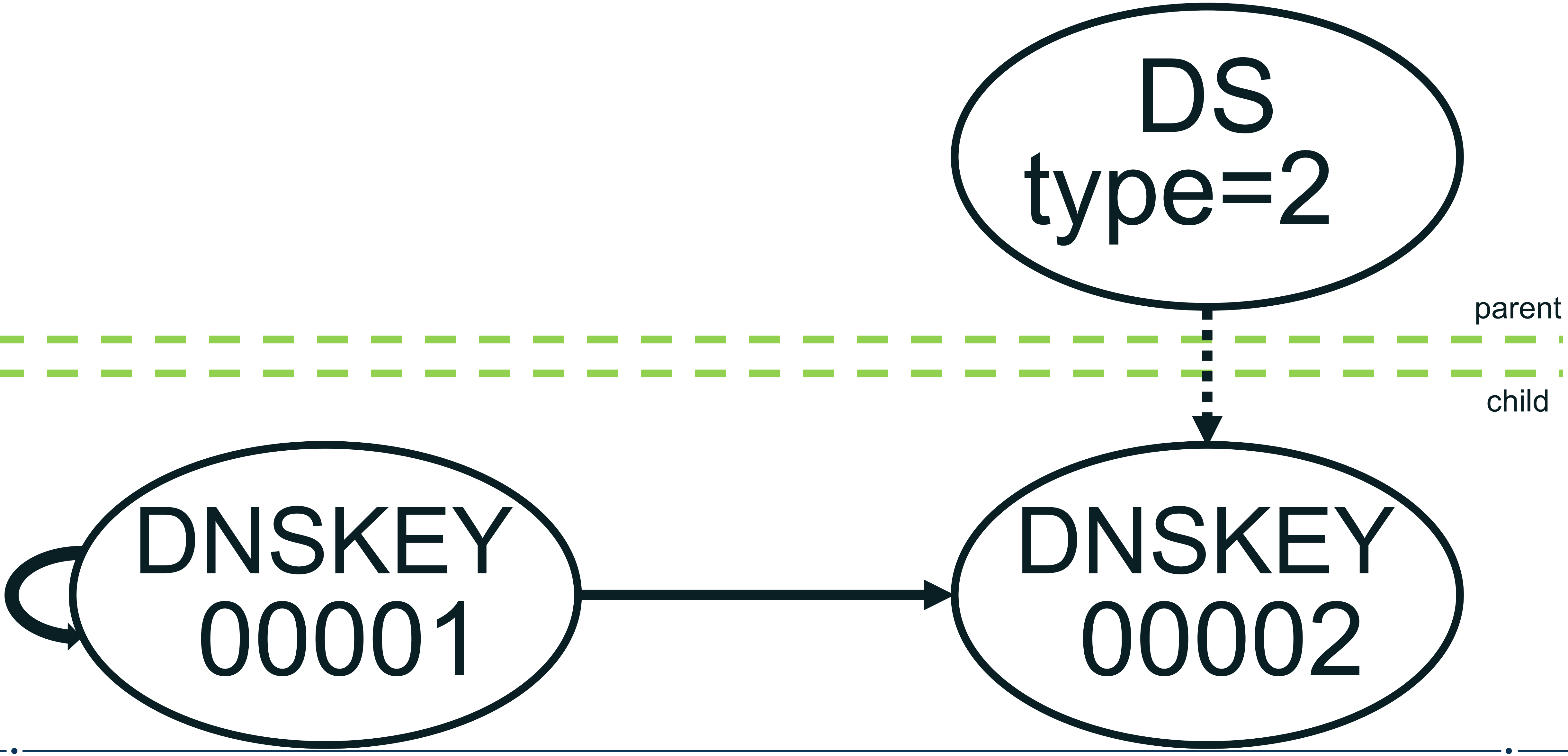

What the standards say

- RFC4509: SHA-256 in DS records

  > 3. Implementation Requirements
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  > Validator implementations SHOULD ignore DS RRs containing SHA-1 digests if DS RRs with SHA-256 digests are present in the DS RRset.

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UPDATES 4035

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OPERATIONAL ADVICE

What do the DNSSEC Operational Practices say? (RFC6781)

- Either use Double Signatures:
  - KSK old and new both sign the DNSKEYset
  - old DS is then replaced by new DS
- Or use Double DS:
  - Both old and new DS are in the parent
  - Old DNSKEY is then replaced by new DNSKEY
- No prescription of the prevention of the failure mode where DS with SHA1 is ignored in the presence of SHA2

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ABSOLUTELY NOTHING

Notes on chains of trust

- Some top level domains have two DS records per DNSKEY in the root zone.
  - Using different Digest Algorithms
- Highest recorded number of DS records for a single TLD since the root was signed:
  - 8 .US DS records, referring to 4 DNSKEYs, using 2 Digest Algorithms
- Current highest number of unique keytags:
  - 3 DS records, all unique keys, same Digest algorithm
- Some stats:
  - 1398 TLDS with chains of trust
  - 184 TLDS with self signed KSKs that do not have DS records.
  - 202 TLDS with KSKs that do have DS records, but are not self-signed.
  - 81 TLDS with DS, but no keys.

What is this trying to prevent

- To prevent a on-path downgrade attack in the following scenario:
  - DS records with SHA1 and SHA256 point to KSK
  - Attacker has a second pre-image for DS SHA1
    - (the second pre-image is a working alternative KSK)
  - Validator accepts DS SHA1 and alternative KSK
    - (DS SHA256 and alternative KSK are no match so will not be considered)

- Multiple variations of this exist, but they all have two things in common:
  - On-path attack
    - (The attacker is a Man-in-the-Middle)
  - The attacker is able to generate a working DNSKEY that has the same digest and keytag as the victim KSK (aka a second pre-image)
    - (This is not the ”shattered” attack where a SHA1 collision was found)

The Missing Advice

- Be consistent is using digest types in DS records
  - Use the same digest type(s) for every KSK.
- Don’t rely on your parent to figure it out for you.
  - Often Garbage-In, Garbage-Out
- Its 2018. You don’t have to use SHA1, you can safely use SHA256.
- Do not roll the KSK and the DS digest type at the same type
  - Either roll the KSK OR roll the DS digest type
- If there is a DNSSEC Best Current Practises 3, this should be added.

Engage with ICANN

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