Sphinx Packets

Decentralized Header Construction

Aurélien Chassagne

February 18, 2025

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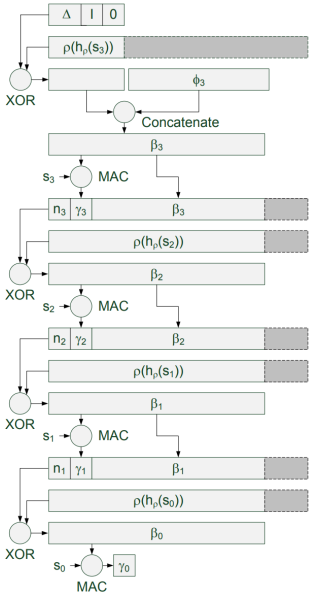

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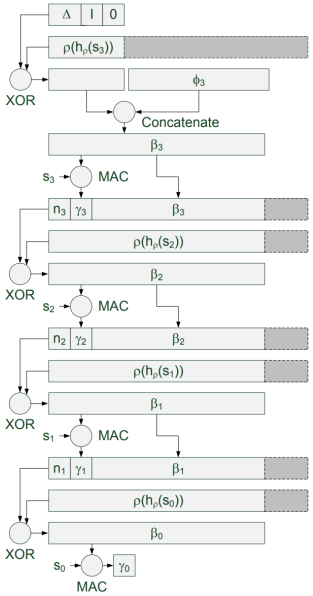

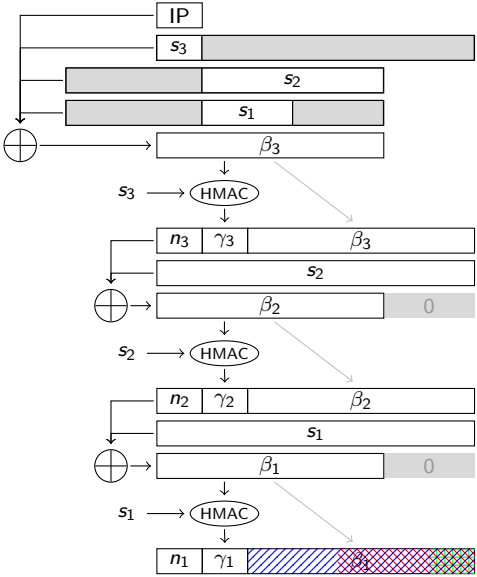

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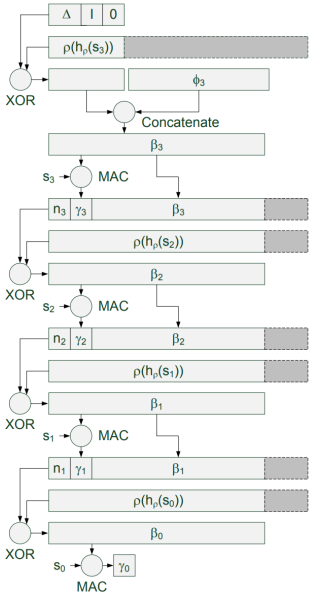

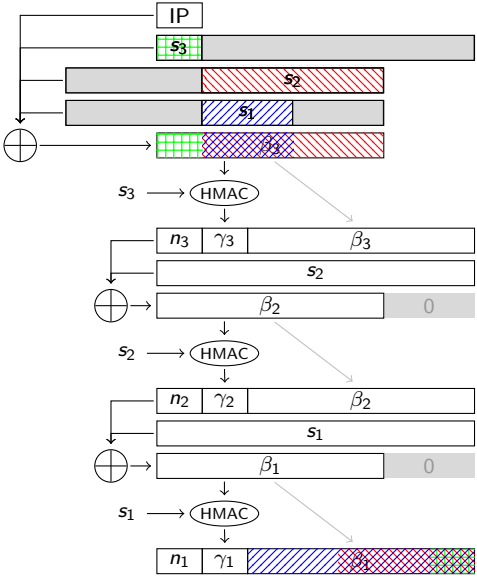

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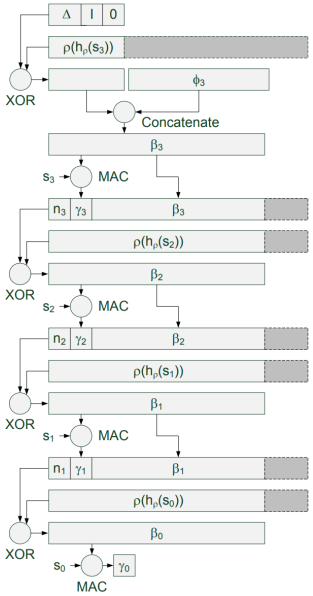

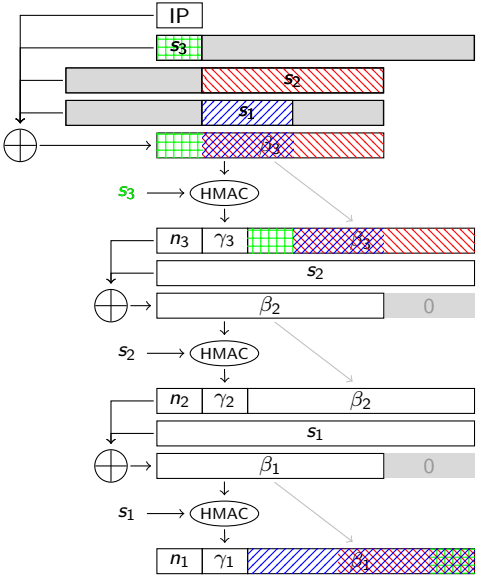

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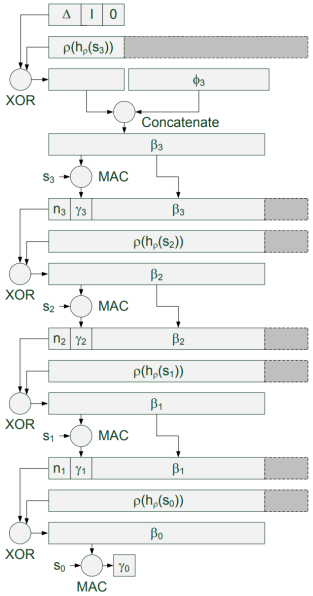

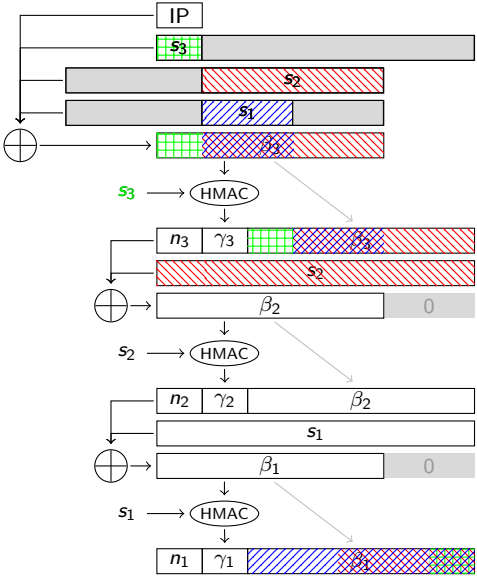

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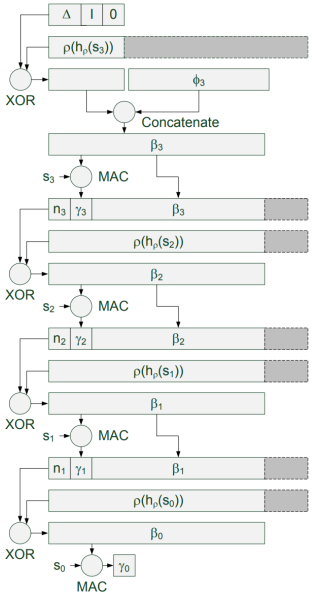

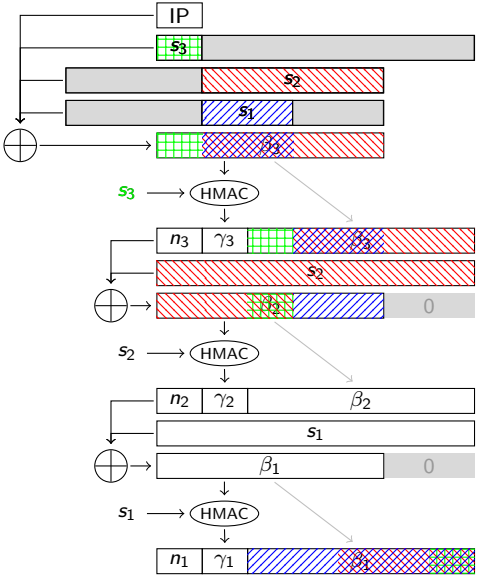

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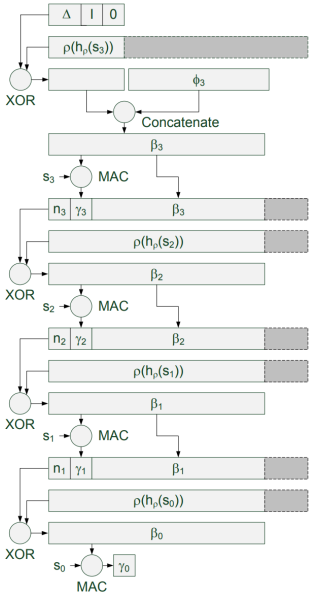

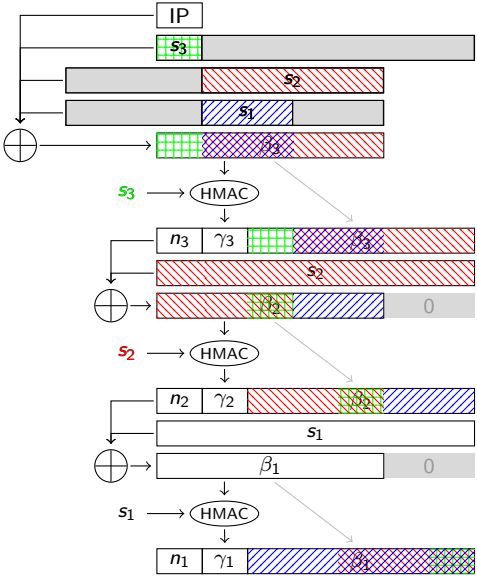

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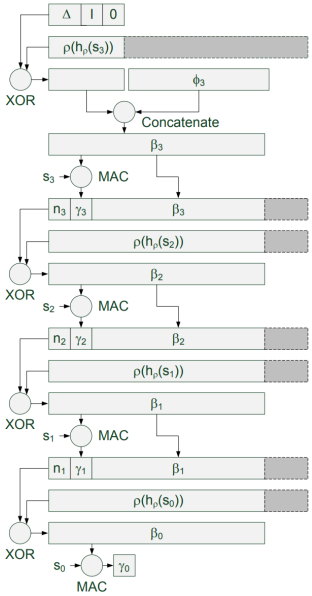

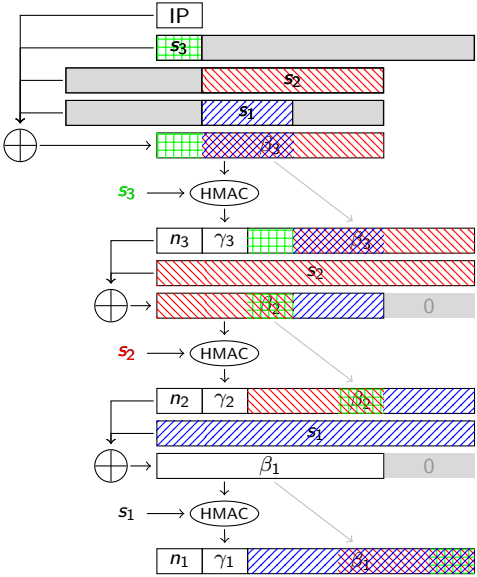

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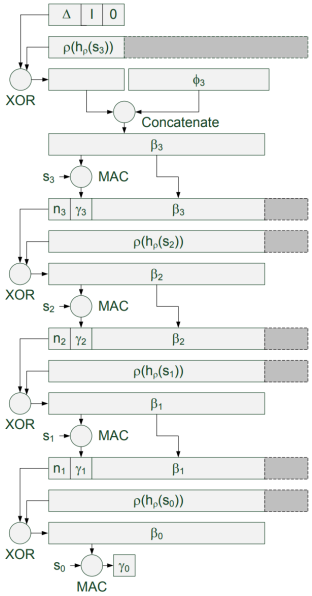

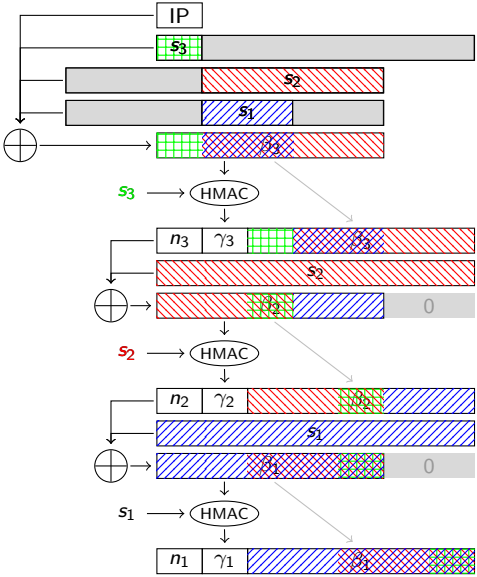

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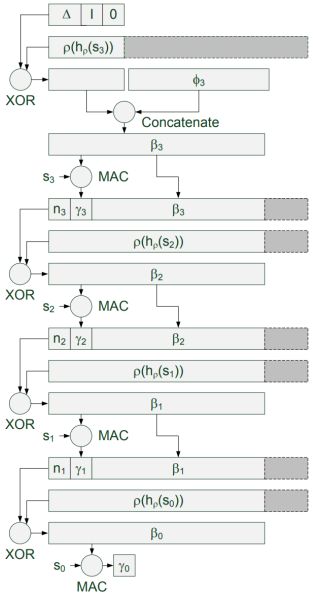
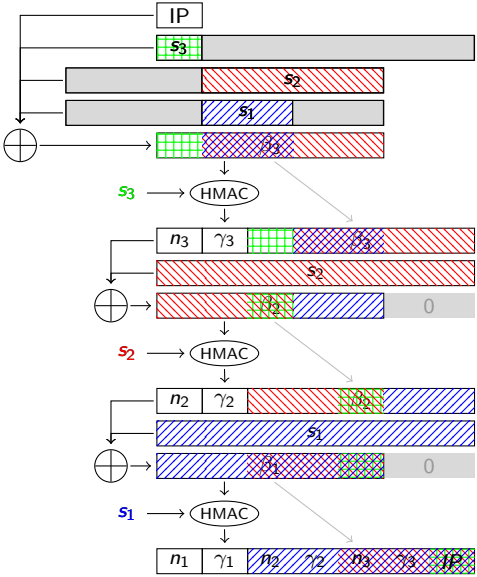
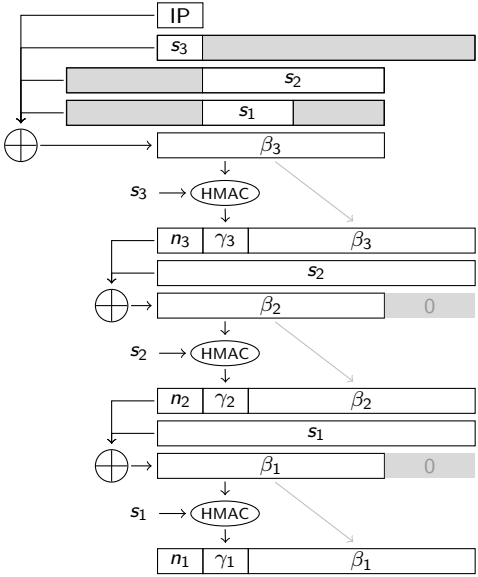


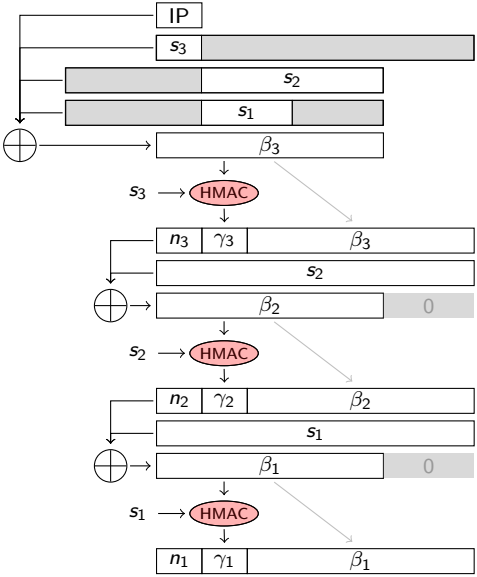


Adapting HMAC



Adapting HMAC

Main problem: Decentralizing a **Hash** ?



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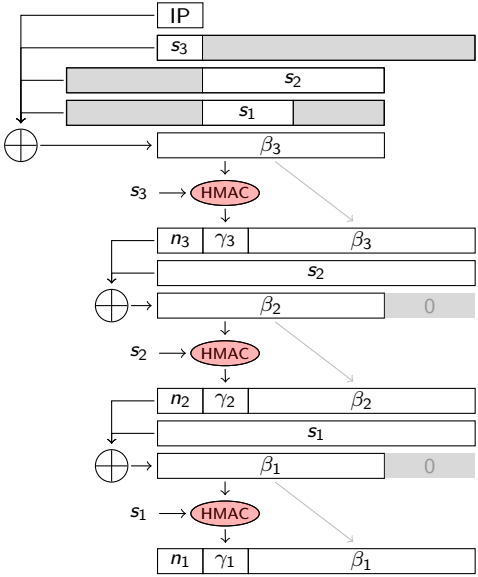
Main problem: Decentralizing a **Hash** ?

- Need **homomorphic properties** to split computation and aggregate results.



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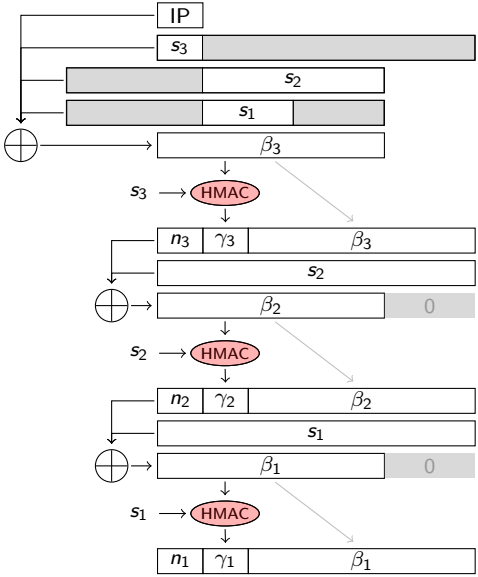

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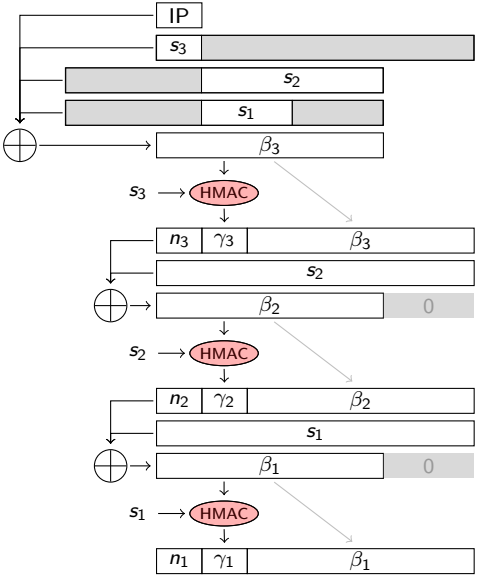

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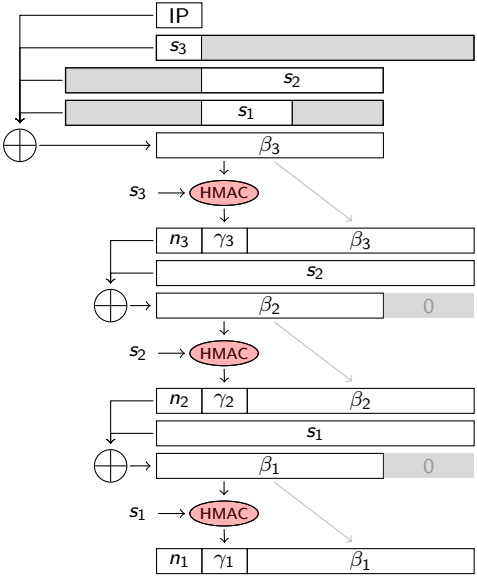

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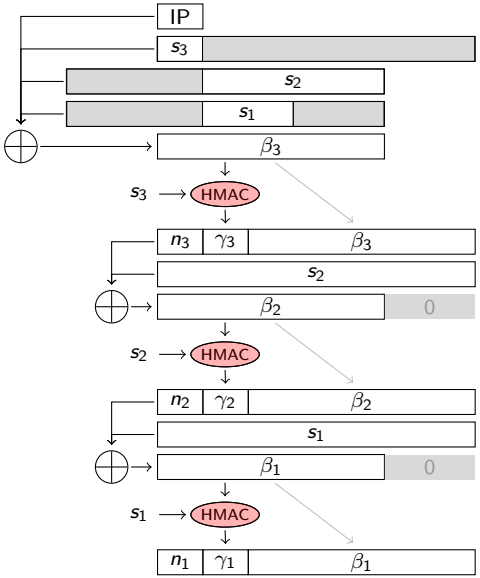
$$\begin{aligned}\mathcal{E}(m_1)\cdot\mathcal{E}(m_2) &= (g^{m_1} r_1^n)(g^{m_2} r_2^n) \bmod n^2 \\ &= g^{m_1+m_2}(r_1 r_2)^n \bmod n^2 \\ &= \mathcal{E}(m_1+m_2).\end{aligned}$$

Problem: Mix of different operations... order matters!



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$$= (g^{r_1+r_2}, (m_1 \cdot m_2)h^{r_1+r_2})$$
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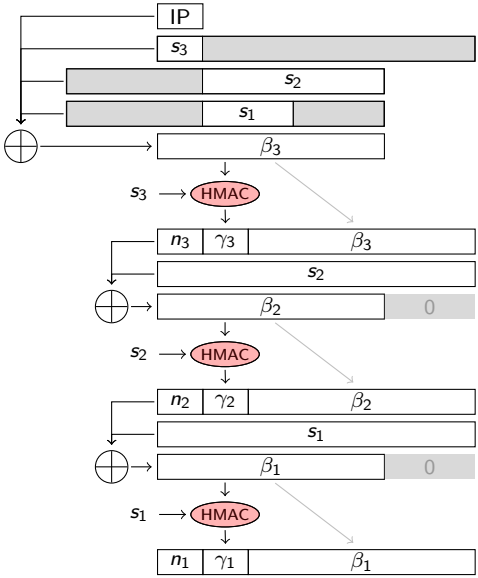
3. **Paillier**

Limitation: Increase ciphertext size...



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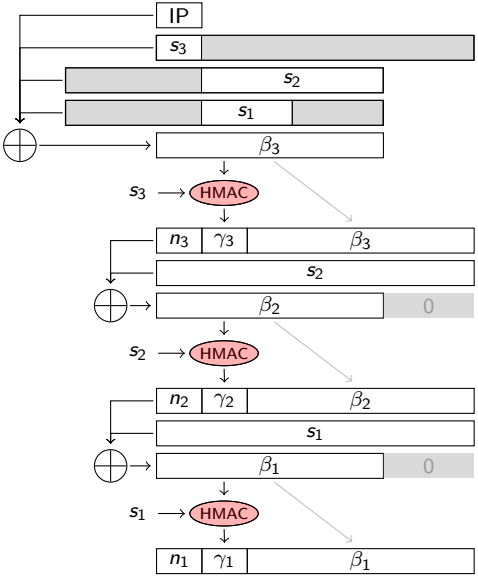

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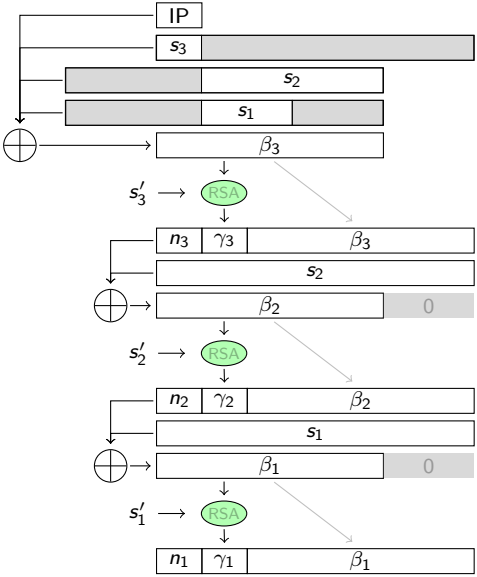
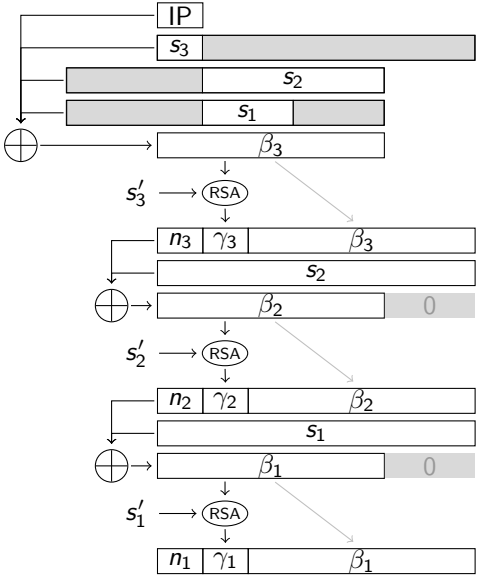
Selected solution: RSA for integrity tag

NB: s_i is different for each TTP but RSA required the same e...
Thus, create a new shared secret s'_i common to all TTP



Adapting XOR



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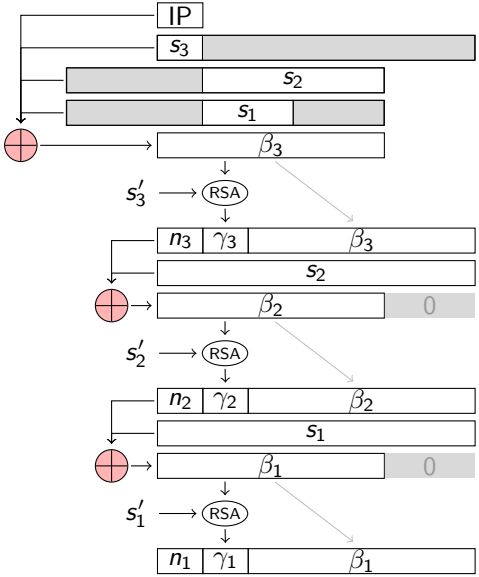
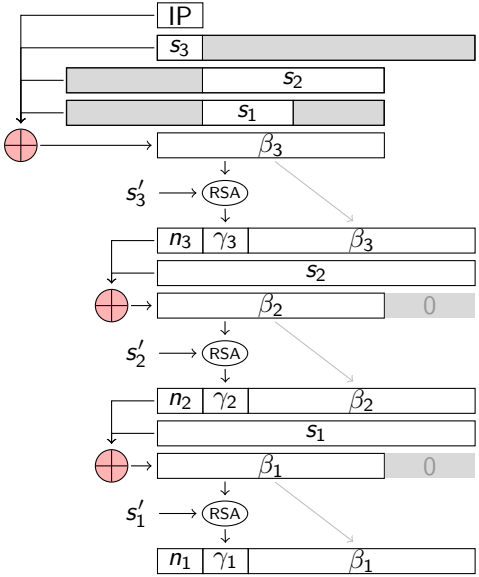


Adapting XOR

Since we use **RSA** for integrity tag γ_i



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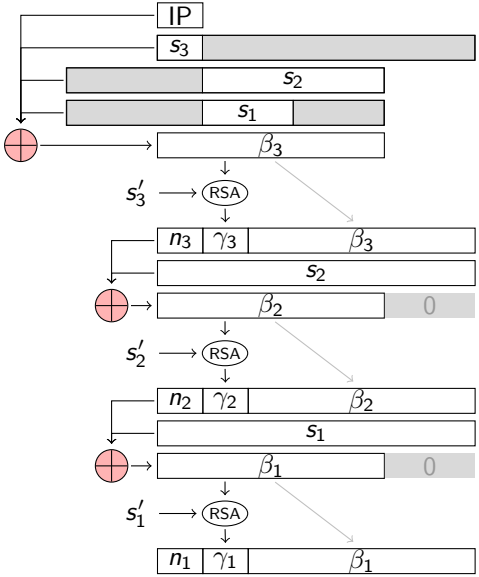

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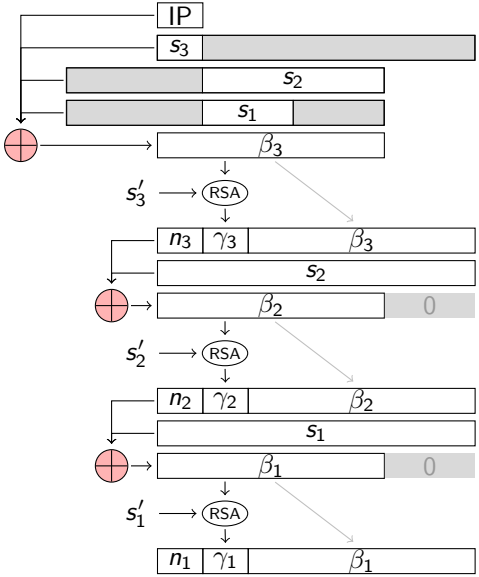
Modular multiplication of integrity tags gives integrity tag of headers' modular product.



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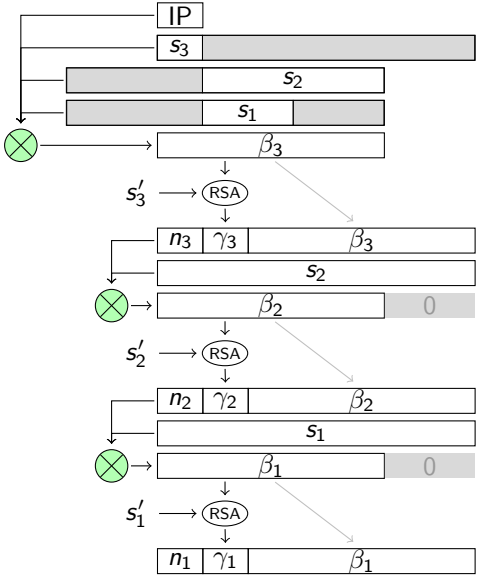
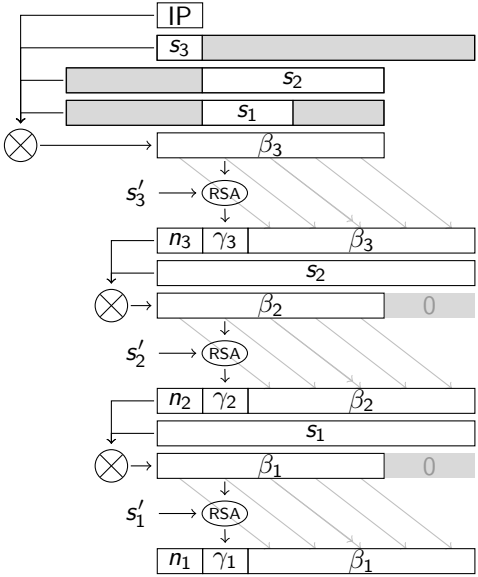
Modular multiplication of integrity tags gives integrity tag of headers' modular product.

Thus, header elements must be combined via modular multiplication rather than XOR.

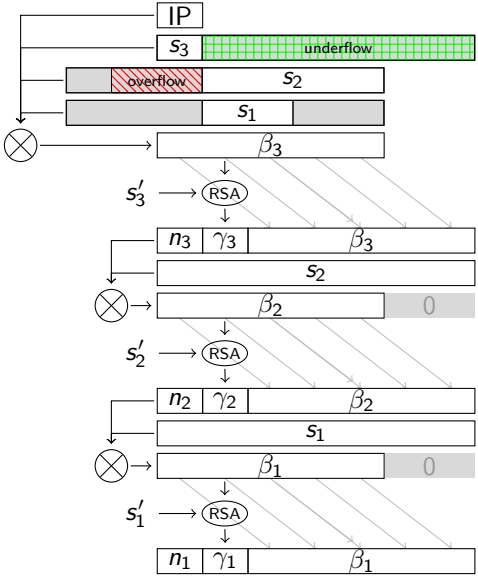


Handle overflows



Handle overflows

- **Current Challenge: Overflow** issues



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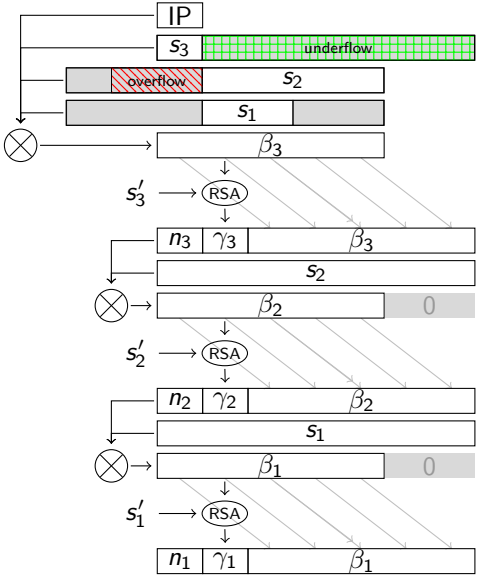
- **Current Challenge: Overflow** issues
- Handling these issues is challenging. It may lead to **information loss** (further research is required).



Handle overflows

- **Current Challenge: Overflow** issues
- Handling these issues is challenging. It may lead to **information loss** (further research is required).
- **Proposed solution:** Simplify by **dividing data into small chunks** and processing each chunk modulo its size.