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2. 优化PE方案的验证与分析
   1. PE实现与性能分析

PE的RTL实现分析，各个单元的面积和延迟，关键路径等分析

* 1. 算法映射结果

使用映射工具对算法集映射的结果

* 1. 与不同架构的对比

1. 功能单元消耗对比

算法集在不同架构的映射下阵列所需要的功能单元统计

课题中的架构优化的粒度是功能单元，因此这个表能直接说明课题的优化方案达到的效果

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 架构 | 算法 | 映射行数 | 功能单元使用 | | | | | |
| AU | SH | PER | LOU | LUT | GFM |
| 本文 | AES | 3 | 12 | 12 | 4 | 12 | 4 | 4 |
| DES | 3 | 12 | 12 | 4 | 12 | 4 | 0 |
| SM4 | 3 | 12 | 12 | 4 | 12 | 4 | 0 |
| TWOFISH | 6 | 24 | 24 | 8 | 24 | 8 | 8 |
| RC5 | 4 | 16 | 16 | 5.33 | 16 | 5.33 | 0 |
| CAST128 | 6 | 24 | 24 | 8 | 24 | 8 | 0 |
| SERPENT | 9 | 36 | 36 | 12 | 36 | 12 | 0 |
| BLOWFISH | 3 | 12 | 12 | 4 | 12 | 4 | 0 |
| SEED |  |  |  |  |  |  |  |
| RC6 |  |  |  |  |  |  |  |
| IDEA |  |  |  |  |  |  |  |
| CAMELLIA |  |  |  |  |  |  |  |
| GOST |  |  |  |  |  |  |  |
| TEA |  |  |  |  |  |  |  |
| 更多算法 |  |  |  |  |  |  |  |
| 项目中的架构 | AES | 4 | 16 | 16 | 8 | 96 | 8 | 0 |
| DES | 4 | 16 | 16 | 8 | 96 | 8 | 0 |
| SM4 | 4 | 16 | 16 | 8 | 96 | 8 | 0 |
| TWOFISH | 6 | 24 | 24 | 12 | 144 | 12 | 0 |
| RC5 | 4 | 16 | 16 | 8 | 96 | 8 | 0 |
| CAST128 | 5 | 20 | 20 | 10 | 120 | 10 | 0 |
| SERPENT | 8 | 32 | 32 | 16 | 192 | 16 | 0 |
| BLOWFISH | 4 | 16 | 16 | 8 | 96 | 8 | 0 |
| SEED |  |  |  |  |  |  |  |
| RC6 |  |  |  |  |  |  |  |
| IDEA |  |  |  |  |  |  |  |
| CAMELLIA |  |  |  |  |  |  |  |
| GOST |  |  |  |  |  |  |  |
| TEA |  |  |  |  |  |  |  |
| 更多算法 |  |  |  |  |  |  |  |
| Cyptoraptor | AES | 2 | 8 | 8 | 8 | 48 | 8 | 0 |
| DES | 3 | 12 | 12 | 12 | 72 | 12 | 0 |
| SM4 | 4 | 16 | 16 | 16 | 96 | 16 | 0 |
| TWOFISH | 5 | 20 | 20 | 20 | 120 | 20 | 0 |
| RC5 | 4 | 16 | 16 | 16 | 96 | 16 | 0 |
| CAST128 | 5 | 20 | 20 | 20 | 120 | 20 | 0 |
| SERPENT | 7 | 28 | 28 | 28 | 168 | 28 | 0 |
| BLOWFISH | 3 | 12 | 12 | 12 | 72 | 12 | 0 |
| SEED |  |  |  |  |  |  |  |
| RC6 |  |  |  |  |  |  |  |
| IDEA |  |  |  |  |  |  |  |
| CAMELLIA |  |  |  |  |  |  |  |
| GOST |  |  |  |  |  |  |  |
| TEA |  |  |  |  |  |  |  |
| 更多算法 |  |  |  |  |  |  |  |
| RCPA | AES | 2 | 8 | 8 | 8 | 16 | 8 | 8 |
| DES | 3 | 12 | 12 | 12 | 24 | 12 | 0 |
| SM4 | 12 | 48 | 48 | 48 | 96 | 48 | 0 |
| TWOFISH | 6 | 24 | 24 | 24 | 48 | 24 | 24 |
| RC5 | 4 | 16 | 16 | 16 | 32 | 16 | 0 |
| CAST128 | 5 | 20 | 20 | 20 | 20 | 20 | 0 |
| SERPENT | 7 | 28 | 28 | 28 | 56 | 28 | 0 |
| BLOWFISH | 3 | 12 | 12 | 12 | 24 | 12 | 0 |
| SEED |  |  |  |  |  |  |  |
| RC6 |  |  |  |  |  |  |  |
| IDEA |  |  |  |  |  |  |  |
| CAMELLIA |  |  |  |  |  |  |  |
| GOST |  |  |  |  |  |  |  |
| TEA |  |  |  |  |  |  |  |
| 更多算法 |  |  |  |  |  |  |  |
| COBRA | AES |  |  |  |  |  |  |  |
| DES |  |  |  |  |  |  |  |
| SM4 |  |  |  |  |  |  |  |
| TWOFISH |  |  |  |  |  |  |  |
| RC5 |  |  |  |  |  |  |  |
| CAST128 |  |  |  |  |  |  |  |
| SERPENT |  |  |  |  |  |  |  |
| BLOWFISH |  |  |  |  |  |  |  |
| SEED |  |  |  |  |  |  |  |
| RC6 |  |  |  |  |  |  |  |
| IDEA |  |  |  |  |  |  |  |
| CAMELLIA |  |  |  |  |  |  |  |
| GOST |  |  |  |  |  |  |  |
| TEA |  |  |  |  |  |  |  |
| 更多算法 |  |  |  |  |  |  |  |
| 更多架构 | AES |  |  |  |  |  |  |  |
| DES |  |  |  |  |  |  |  |
| SM4 |  |  |  |  |  |  |  |
| TWOFISH |  |  |  |  |  |  |  |
| RC5 |  |  |  |  |  |  |  |
| CAST128 |  |  |  |  |  |  |  |
| SERPENT |  |  |  |  |  |  |  |
| BLOWFISH |  |  |  |  |  |  |  |
| SEED |  |  |  |  |  |  |  |
| RC6 |  |  |  |  |  |  |  |
| IDEA |  |  |  |  |  |  |  |
| CAMELLIA |  |  |  |  |  |  |  |
| GOST |  |  |  |  |  |  |  |
| TEA |  |  |  |  |  |  |  |
| 更多算法 |  |  |  |  |  |  |  |

1. 面积、性能对比

这个对比是一般论文都会有的对比，也是杨博在汇报时提的要求。和论文中的对比会出现工艺对齐的问题，这些论文中都给出了阵列的门数，面积的对比有一定的参考意义。但是不同的工艺下性能是没有可比性的。

杨博只要求和清华目前的PE进行对比，这个是可以做到的，到时可以使用相同的工艺库进行综合。

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 架构 | 本文 | | | 项目中的架构 | | | Cyptoraptor | | |
| 工艺/nm | 65 | | | 65 | | | 45 | | |
| 主频/MHz | 1000/3.97 | | | 1000/3.97 | | | 1000 | | |
|  | 算法映射面积/Mgates | 性能/Gbps | 性能面积比**/(Gbps/Mgates)** | 算法映射面积 | 性能 | 性能面积比 | 算法映射面积 | 性能 | 性能面积比 |
| AES |  |  |  |  |  |  |  |  |  |
| DES |  |  |  |  |  |  |  |  |  |
| SM4 |  |  |  |  |  |  |  |  |  |
| TWOFISH |  |  |  |  |  |  |  |  |  |
| RC5 |  |  |  |  |  |  |  |  |  |
| CAST128 |  |  |  |  |  |  |  |  |  |
| SERPENT |  |  |  |  |  |  |  |  |  |
| RC6 |  |  |  |  |  |  |  |  |  |
| SEED |  |  |  |  |  |  |  |  |  |
| BLOWFISH |  |  |  |  |  |  |  |  |  |
| IDEA |  |  |  |  |  |  |  |  |  |
| CAMELLIA |  |  |  |  |  |  |  |  |  |
| GOST |  |  |  |  |  |  |  |  |  |
| TEA |  |  |  |  |  |  |  |  |  |
| XTEA |  |  |  |  |  |  |  |  |  |
| SKIPJECT |  |  |  |  |  |  |  |  |  |
| SPECK |  |  |  |  |  |  |  |  |  |
| SIMON |  |  |  |  |  |  |  |  |  |
| LUCIFER |  |  |  |  |  |  |  |  |  |
| 更多算法 |  |  |  |  |  |  |  |  |  |

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 架构 | RCPA | | | CORBA | | | Celator等更多架构 | | |
| 工艺/nm |  | | |  | | |  | | |
| 主频/MHz |  | | |  | | |  | | |
|  | 算法映射面积/Mgates | 性能/Gbps | 性能面积比**/(Gbps/Mgates)** | 算法映射面积 | 性能 | 性能面积比 | 算法映射面积 | 性能 | 性能面积比 |
| AES |  |  |  |  |  |  |  |  |  |
| DES |  |  |  |  |  |  |  |  |  |
| SM4 |  |  |  |  |  |  |  |  |  |
| TWOFISH |  |  |  |  |  |  |  |  |  |
| RC5 |  |  |  |  |  |  |  |  |  |
| CAST128 |  |  |  |  |  |  |  |  |  |
| SERPENT |  |  |  |  |  |  |  |  |  |
| RC6 |  |  |  |  |  |  |  |  |  |
| SEED |  |  |  |  |  |  |  |  |  |
| BLOWFISH |  |  |  |  |  |  |  |  |  |
| IDEA |  |  |  |  |  |  |  |  |  |
| CAMELLIA |  |  |  |  |  |  |  |  |  |
| GOST |  |  |  |  |  |  |  |  |  |
| TEA |  |  |  |  |  |  |  |  |  |
| XTEA |  |  |  |  |  |  |  |  |  |
| SKIPJECT |  |  |  |  |  |  |  |  |  |
| SPECK |  |  |  |  |  |  |  |  |  |
| SIMON |  |  |  |  |  |  |  |  |  |
| LUCIFER |  |  |  |  |  |  |  |  |  |
| 更多算法 |  |  |  |  |  |  |  |  |  |

* 1. 本章小结

1. 总结与展望

Hütter, Markus, Johann Großschädl, and Guy-Armand Kamendje. "A versatile and scalable digit-serial/parallel multiplier architecture for finite fields GF (2 m)."*Information Technology: Coding and Computing [Computers and Communications], 2003. Proceedings. ITCC 2003. International Conference on*. IEEE, 2003.

Cordella, Luigi P., et al. "A (sub) graph isomorphism algorithm for matching large graphs." *Pattern Analysis and Machine Intelligence, IEEE Transactions on* 26.10 (2004): 1367-1372.