Bridging the Gap Between the SP 800-90 Series and AIS 20/31

Kerry McKay
RBG Workshop 2023
May 31, 2023
Overview

• Ongoing work between NIST and BSI to harmonize standards and guidelines on random number generation

• Main goal is to make it easier for a RBG/RNG design to pass validation testing according to both standards

• Writing a joint document
  • Similarities and different requirements for harmonization
  • Comparison of
    • Functionality Classes of AIS 20/31
    • Random Bit Constructions of SP 800-90 series
Randomness Standards

- SP 800-90A: Recommendation for Random Number Generation Using Deterministic Random Bit Generators
- SP 800-90B: Recommendation for the Entropy Sources used for Random Bit Generation
- SP 800-90C: Recommendation for Random Bit Generator Constructions
  - Draft September 2022
- AIS 20: Functionality Classes and Evaluation Methodology for Deterministic Random Number Generators
- AIS 31: Functionality Classes and Evaluation for Physical Random Number Generators
- Both point to a joint mathematical-technical reference, often simply called ‘AIS 20/31’
  - Draft September 2022
## Functionality Classes vs. RBG Constructions

<table>
<thead>
<tr>
<th>BSI Functionality Class</th>
<th>NIST Construction</th>
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<tbody>
<tr>
<td>DRG.2</td>
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</tr>
<tr>
<td>DRG.3</td>
<td>RBG1</td>
</tr>
<tr>
<td>DRG.4</td>
<td>RBG2(P)</td>
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<tr>
<td>PTG.2</td>
<td>Physical entropy source</td>
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<tr>
<td>PTG.3</td>
<td>RBG3(RS)</td>
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<tr>
<td>NTG.1</td>
<td>RBG2(NP)</td>
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<tr>
<td>PTG.2 + DRG.3, or at best PTG.3</td>
<td>RBG3(XOR)</td>
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</table>
PTG.2 and Entropy Source

- Physical noise source
- Postprocessing (optional)
- Online test, total failure test, start-up test
- Entropy per output bit ≥ PTG.2-specific bound
- *Not intended for ‘direct’ use*

- Physical or non-physical noise source
- Conditioning (optional)
- Health tests
- No hard limit on entropy per bit value
- *Not intended for ‘direct’ use*
# Additional Requirements

## Validating PTG.2 as an entropy source
- On-demand tests, continuous tests
- Tests and predictors specified in SP 800-90B

## Certifying an entropy source as PTG.2
- Noise from physical source
- Outputs follow [time-locally] stationarily distributed raw random numbers
- Entropy/bit $\geq$ PTG.2-specific bound (can be achieved by additional conditioning)
- Stochastic model
- Verification that the online test and the total failure test are effective
- Black box test suites
DRG.3 and RBG1

- Non-approved designs (security proofs required)
- Backward secrecy, forward secrecy and enhanced backward secrecy
- Appropriate seeding process
  - External true RNG (in particular: PTG.2, PTG.3, NTG.1)

\begin{itemize}
  \item Non-approved designs (security proofs required)
  \item Backward secrecy, forward secrecy and enhanced backward secrecy
  \item Appropriate seeding process
    \begin{itemize}
      \item External true RNG (in particular: PTG.2, PTG.3, NTG.1)
    \end{itemize}
\end{itemize}

- Approved designs (SP 800-90A conformance)
- Backtracking resistance
- Appropriate seeding process
  - External randomness source: RBG2(P), RBG3

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  \item Approved designs (SP 800-90A conformance)
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  \item Appropriate seeding process
    \begin{itemize}
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    \end{itemize}
\end{itemize}
### Validating DRG.3 as RBG1
- SP 800-90A-approved design
- Seeding only with a physical RNG
  - PTG.2, PTG.3: min-entropy claim needed
  - Seed string contains enough entropy (DRG.3: ≥ 240 bit min-entropy after seeding)
- Known-answer test

### Certifying RBG1 as DRG.3
- Verification of the algorithmic requirements of class DRG.3 (e.g., effective internal state: (i) size ≥ 252 bits, (ii) min-entropy after seeding ≥ 240 bits)
  - Waived for Hash_DRBG (Hash ≠ SHA-1)
- Seed with PTG.2, PTG.3, or NTG.1
- Possibly: more detailed proof of the seed entropy
DRG.4 and RBG2(P)

DRG.4
- Non-approved designs (security proofs required)
- Backward and forward secrecy
- Enhanced backward and forward secrecy
- Appropriate (re-)seeding process or additional high-entropy input
  - Physical RNG (in particular: PTG.2, PTG.3)

RBG2(P)
- Approved designs (SP 800-90A conformance)
- Backtracking and prediction resistance
- Appropriate (re-)seeding process
  - 90B-compliant internal physical entropy source
## Additional Requirements

### Validating DRG.4 as RBG2(P)
- SP 800-90A-approved design
- Prediction resistance only by reseeding from PTG.2, PTG.3
- Seed string contains enough entropy (DRG.3: ≥ 240 bit min-entropy after (re-)seeding)
- Known-answer test
- PTG.2, PTG.3: min-entropy claim needed

### Certifying RBG2(P) as DRG.4
- Verification of the algorithmic requirements of class DRG.4
  - Waived for Hash_DRBG (Hash ≠ SHA-1)
- Stochastic model for randomness source
  - Satisfied if PTG.2, PTG.3 (RBG3(RS), RBG3(XOR) should also be appropriate)
NTG.1 and RBG2(NP)

- Non-physical noise source
- DRG.3-compliant postprocessing algorithm
- Min-entropy claim / output bit: at least 0.98

RBG2(NP)
- Non-physical noise source
- Approved designs (SP 800-90A conformance)
- Backtracking and prediction resistance
- Appropriate (re-)seeding process
  - 90B-compliant internal non-physical entropy source
### Validating NTG.1 as RBG2(NP)

- SP 800-90A-approved postprocessing
- Fresh entropy only by reseeding
- Known-answer test
- Tests and predictors specified in SP 800-90B

### Certifying RBG2(NP) as NTG.1

- Permanently fresh entropy
- Verification of the algorithmic requirements of class DRG.3
  - Waived for Hash_DRBG (Hash ≠ SHA-1)
PTG.3 and RBG3(RS)

- Physical noise source, usual case: PTG.2-compliant intermediate random numbers (input to postprocessing with memory, compliant to DRG.3)
- Postprocessing: data compression possible
- Maximum min-entropy claim / output bit: $1 - 2^{-32}$

- SP 800-90B-compliant internal physical entropy source
- Deterministic part: 90A-approved design
## Additional Requirements

### Validating PTG.3 as RBG3(RS)

- SP 800-90A approved postprocessing
- Fresh entropy only by reseeding
- Min-entropy claim / output bit: $1 - 2^{-32}$ bit
- On-demand test, continuous test
- Known-answer test
- Tests and predictors specified in SP 800-90B

### Certifying RBG3(RS) as PTG.3

- (Time-locally) stationarily distributed raw random numbers
- Stochastic model
- Verification that the online test and the total failure test are effective
- Postprocessing: verification of the algorithmic requirements of class DRG.3
  - Waived for hash_drbg (hash ≠ SHA-1)
- Black box test suites
Next Steps

• BSI and NIST in the process harmonizing RBG/RNG terminology of AIS 20/31 and SP 800-90
  • Some requirements harmonized as well
• A draft of a joint document (NIST & BSI) will be published soon
  • Contains comparisons of functionality classes and RBG constructions
  • Includes a joint glossary
Questions?
Thanks!