To create a structured assurance case for the ACAS Xu using the Goal Structuring Notation (GSN), we need to outline strategic GSN elements such as Goals, Contexts, Strategies, and Solutions. Here's how you can structure it in a hierarchical tree format:

1. \*\*Top-Level Goal (G1)\*\*

- Ensure the ACAS Xu system is secure against threats and resilient in operation.

- \*\*Context (C1)\*\*

- Description of ACAS Xu system functionalities, environment, and operational requirements.

- \*\*Strategy (S1)\*\*

- Divide security verification into system security architecture, external threats, and data integrity.

2. \*\*Sub-Goal (G1.1) – Security Architecture Adequacy\*\*

- Establish that the security architecture of ACAS Xu is sufficient for intended operation.

- \*\*Context (C1.1)\*\*

- Overview of ACAS Xu architecture, including hardware and software components.

- \*\*Strategy (S1.1)\*\*

- Analyze each component for potential vulnerabilities and mitigation strategies.

- \*\*Solution (S1.1.1)\*\*

- Security risk assessment report for ACAS Xu components.

3. \*\*Sub-Goal (G1.2) – Resilience Against External Threats\*\*

- Demonstrate resistance and recovery from cyber-physical attacks.

- \*\*Context (C1.2)\*\*

- Description of assumed threat models relevant to avionics.

- \*\*Strategy (S1.2)\*\*

- Evaluation of system response under simulated attack scenarios.

- \*\*Solution (S1.2.1)\*\*

- Test results showing system behavior under attack conditions.

4. \*\*Sub-Goal (G1.3) – Data Integrity Verification\*\*

- Ensure integrity and authenticity of data used and generated by ACAS Xu.

- \*\*Context (C1.3)\*\*

- Information on data handling, sources, and protocols in ACAS Xu.

- \*\*Strategy (S1.3)\*\*

- Validate mechanisms for data protection and error checking.

- \*\*Solution (S1.3.1)\*\*

- Certification results from data integrity checks and encryption methods used.

5. \*\*Sub-Goal (G1.4) – Compliance with Aviation Cybersecurity Guidelines\*\*

- Prove compliance with national and international cybersecurity guidelines for avionics systems.

- \*\*Context (C1.4)\*\*

- List relevant aviation cybersecurity standards and regulations (e.g., DO-326A/ED-202).

- \*\*Strategy (S1.4)\*\*

- Cross-reference system security features against compliance checklists.

- \*\*Solution (S1.4.1)\*\*

- Compliance report detailing adherence to cybersecurity guidelines.

6. \*\*Sub-Goal (G1.5) – Continuous Security Monitoring\*\*

- Maintain continuous monitoring and update defenses in response to emerging threats.

- \*\*Context (C1.5)\*\*

- Outline of the ongoing security monitoring practices.

- \*\*Strategy (S1.5)\*\*

- Establish protocols for continuous security assessment and updates.

- \*\*Solution (S1.5.1)\*\*

- Documented security update and incident response procedures.

7. \*\*Sub-Goal (G1.6) – User Training and Awareness\*\*

- Ensure that all relevant personnel are trained on the use and security features of ACAS Xu.

- \*\*Context (C1.6)\*\*

- Details on user roles and interaction with ACAS Xu.

- \*\*Strategy (S1.6)\*\*

- Develop and implement a comprehensive security training program.

- \*\*Solution (S1.6.1)\*\*

- Training schedule and materials, feedback from training sessions, and improvement metrics.

Each of these goals should be supported by appropriate evidence and context information, forming a comprehensive assurance case to ensure that the ACAS Xu system is adequately secure.